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THE NEW SOUTHERN PACIFIC PASSENGER STATION AT SAN ANTONIO, TEX.

By John D. Isaacs, M. Am. Soc. C. E.*

The Southern Pacific has recently constructed at San Antonio, Texas, a new passenger depot which is worthy of note as being the best recent adaptation of the Mission style of architecture to modern requirements. The key note of the building is the Alamo, which is one of the historical features of the city, but the building, of course, is treated with much more elaborate ornamentation and, so far as its use is concerned, is modern in all respects. The cost of the building, including yard improvements, was about $115,000.

The station is constructed in the best possible manner throughout. It has thick brick walls on concrete foundations. The ground floor contains a large central waiting room running through two stories with an arched ceiling in the basilica style. On this floor are also placed the ticket, telegraph and telephone offices, smoking rooms, private waiting room, retiring room for ladies, and the waiting room for colored people. On the upper floor on one side are the office of the superintendent, dispatchers, clerks and other operating officials; and on the opposite side, the offices of resident engineer, draftsmen and assistants, and the conductors' rooms.

The second story is reached by a grand stairway in the south end of the main waiting room, which leads to a gallery running entirely around the main building, except across the south gable. There is also a private stairway in the northeast corner of the building for the use of officials. In the wing, or one story annex, are the dining room, serving room, the offices of Wells, Fargo & Co., the United States mail, the Pullman Company and the baggage rooms.

The first floor is shaded by an arcade passing entirely around the main building. This arcade, which is omitted from the second floor, in order to give plenty of light to the offices above, is constructed so as to show heavy rough hewn rafters and beams. The openings into the main waiting room are arranged opposite each other on four sides of the building, so that in warm weather they may be thrown open to catch the breeze from any direction.

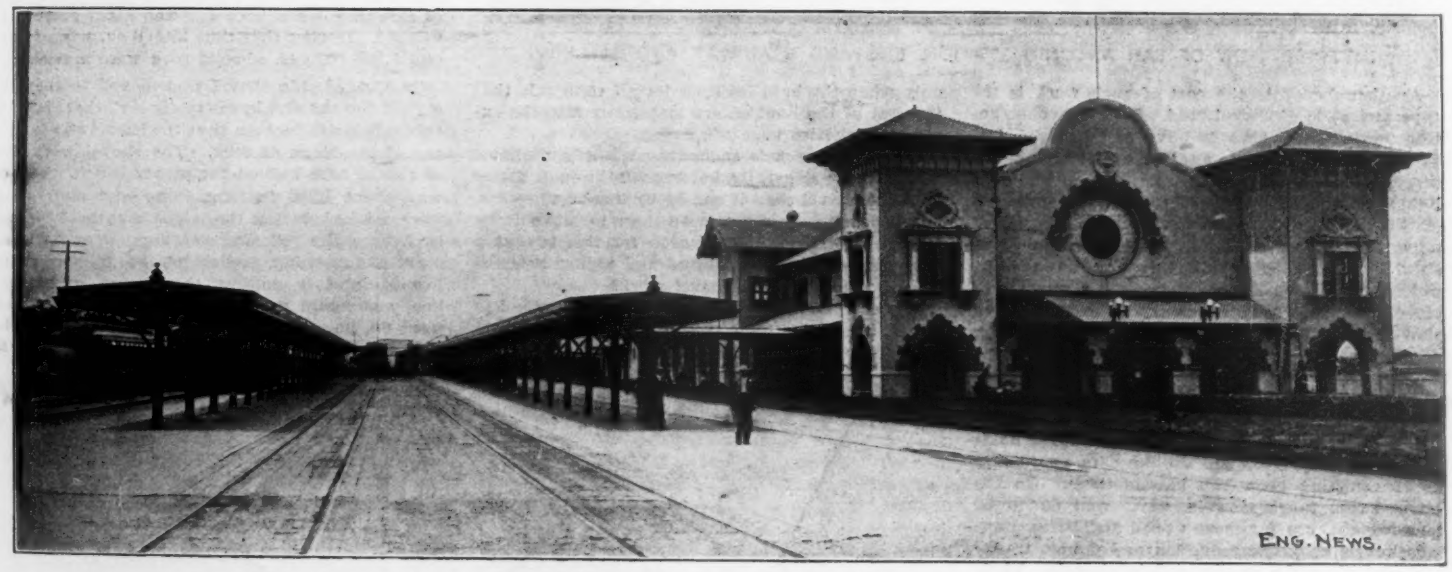
In the main gables, which are at each end of the main waiting room, there are two stained glass rose windows, the one in the north gable showing the medallion of the "Sunset Route," and the one in the opposite, or south gable, the coat of arms of the State of Texas. Other windows are glazed with bevel plate and fancy glass. The skylight over the main waiting room is of Etruscan glass.

The waiting room has a high wainscot of cream white tile. Above this the finish is ornamental plaster. The exterior arches and jambs of the building are of red brick, natural color, while the exterior walls are covered with a yellow stucco. The roof trusses of the main waiting room are of steel. The entire roof is covered with red clay Spanish tile. The exterior ornaments are of manu stone, artistically modeled. The exterior woodwork is painted in greens, browns and reds. The general tone of the interior decorations is ecru, light brown and gold gilt, which, with the great number of incandescent electric lights, distributed on arches, panels and other available points, give a brilliant effect. All the gas and electric fixtures were especially designed and made for this structure.

The building is provided with a low pressure steam heating plant. Umbrella sheds were adopted for shade and shelter along and between the tracks in preference to an inclosed shed, so as to avoid the smoke and noises incident to a complete inclosure. The grounds are being fitted up and when completed will be covered with lawns, flowers, palms and ornamental shrubbery.

The depot was designed by J. D. Isaacs and Assistant Architect D. J. Patterson, assisted by W. E. Milwain, all of the Southern Pacific Co., San Francisco. The work was carried on under the supervision of E. B. Cushing, Engineer, Maintenance of Way, Galveston, Harrisburg & San Antonio, assisted by H. F. Jonas. W. B. Sheldon was superintendent of construction.

*Assistant Engineer of Maintenance-of-Way, Southern Pacific Co., San Francisco, Cal.



THE NEW PASSENGER STATION OF THE SOUTHERN PACIFIC CO., AT SAN ANTONIO, TEXAS.
(View Looking South.)

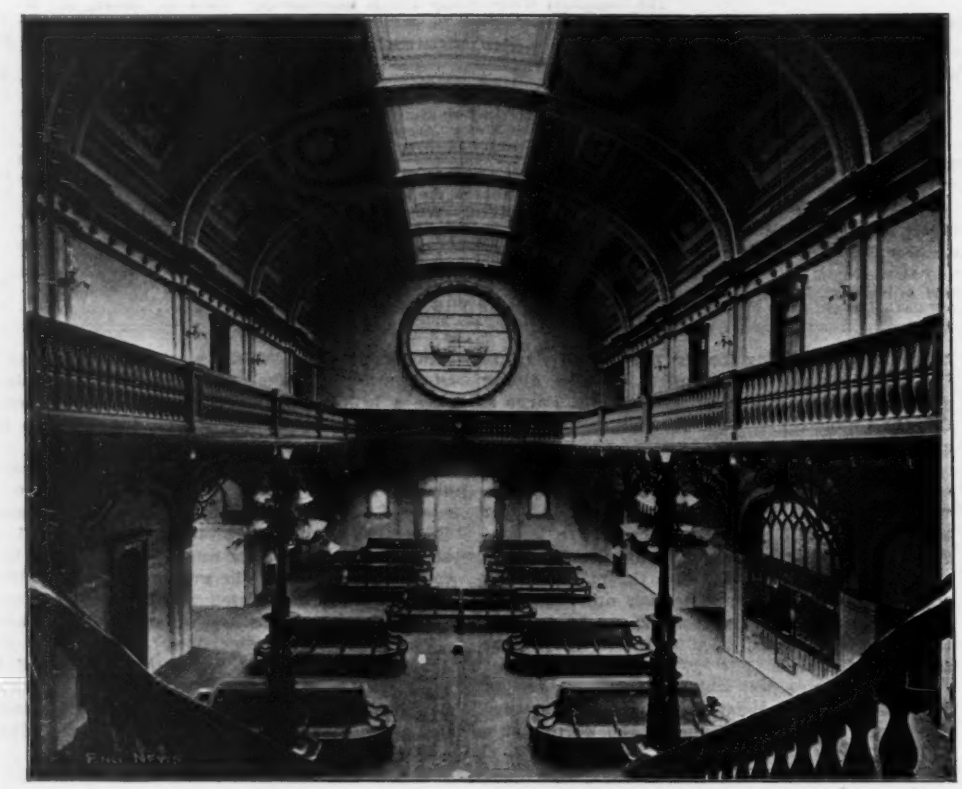
COST OF EARTH EXCAVATION BY STEAM SHOVEL.

By Daniel J. Hauer, C. E.*

The cost of moving earth by a steam shovel varies considerably, and is governed not only by the nature of the material to be moved but also by the character of the work to be done. To make a through cut for a railroad or to excavate a canal with a steam shovel costs far more than almost any other sort of work the shovel can be made to do. To take gravel from a pit, to widen cuts already made, or to borrow earth from a hillside to make large embankments, a shovel can

*La Follette, Tenn.

frequently be made to work almost to its actual capacity (not the capacity put upon the machine by the builders), and the work should cost much less than in through cuts. Steam shovel work in reducing grades is more costly than widening cuts for double track, but if properly handled should be less expensive than making thorough cuts, unless much water is encountered, when the cost of the work is greatly increased.



INTERIOR VIEW OF SAN ANTONIO STATION, SHOWING STAIRWAY AND GALLERY.

Another factor in the cost of such work is the type and style of shovel used. For new construction work, where shovels have to be moved frequently from one cut to another over rough country, a large heavy shovel will not pay as well as a lighter one of, say, from 35 to 45 tons. In work of this nature a shovel has often to work against a low breast, and is thereby compelled to move at short intervals while digging; and as a light weight shovel can be moved in from a quarter to one-third of the time necessary to move a large shovel, less time is lost while working, and a greater output of earth can be made for the same money. Then the consideration of coal and water supply is in favor of the small shovel, as well as the fact that in thorough cuts only small capacity cars can be used and a shovel with a dipper holding 1 to 1½ cu. yds. will fill the cars as quickly as the shifting crew can handle them. On the other hand, large shovels, say, from 65 to 90 tons weight, are far more useful and better paying shovels on grade reduction and double tracking work than the smaller weight shovels. Their range of work is far greater, and as there is a railroad track at hand they can easily be taken from one point to another. The extra fuel and water is more readily supplied, and the larger capacity of the dipper can be utilized, as large dump cars can be used. In work of this nature the shovel, as a rule, works against a much higher breast, so fewer moves of the machine are necessary. Unfortunately, a contractor does not always take into consideration these facts, for he may find himself with a new contract upon which a small shovel can be operated to the best advantage, while he owns only a large shovel, or vice versa, and his financial condition may not seemingly warrant him to make a sacrifice sale and a new purchase. The American method under such circumstances seems to be to attack the job with the outfit in hand, and to depend upon ingenuity, hard work and "the engineers" to come out with a profit, even if it is not the profit that the work should net. In most cases the chances are that to sacrifice some money on the start and secure an outfit fitted to the work will result in a greater profit.

The length of the haul from the pit to the dump, especially when the dirt trains are operated by a locomotive or a dinkey, does not enter into the cost of the excavation as much as when earth is moved by scrapers or wagons. One to two-mile hauls are common in steam shovel work, and it is only when the haul becomes longer than this that the cost of the haul enters materially into the expense of the work.

When solid rock is encountered in steam shovel work, it can generally be excavated much faster with the shovel than it can be by hand and teams, but it frequently costs more than to move it by the latter method. The reason for this is that a more expensive outfit is used and higher salaried men are employed on shovel work.

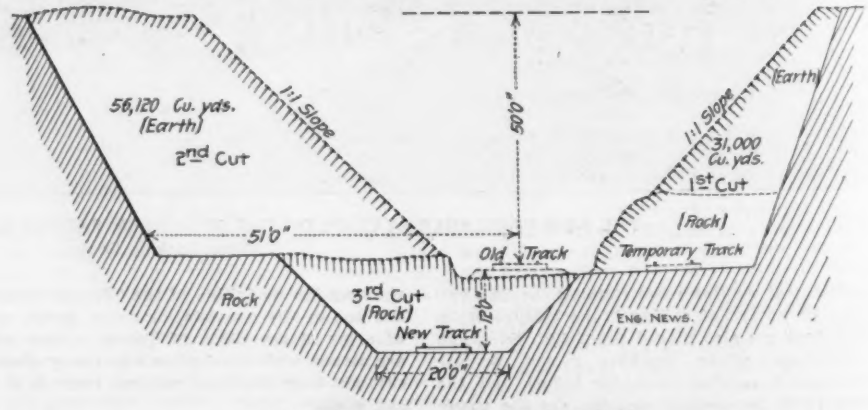
The cost of various kinds of shovel work has not been kept in detail by contractors as it should have been, and it is to be regretted that most of the data that have been kept are guarded by contractors as "stock in trade," when an exchange of ideas on the subject, especially as to costs, would be of benefit to all concerned, both contractors and engineers, as well as the companies that have the work to let. Hardly any two pieces of work will cost the same, but to have records of the cost of similar work will not only enable the contractor to make a fair profit-making bid, but will also aid the engineer in knowing that he is receiving such a bid for the work, instead of awarding the work to the lowest bidder, who may lose money himself and cause the company to do the same.

Mr. H. P. Gillette, in his excellent book on the "Earthwork and Its Cost," has furnished more data on this subject than any writer has yet given to the construction world. His able work should act as an incentive for more in the same line. In referring to such published information both contractor and engineer should be careful in applying it to the work he may have at hand, as the local conditions and seemingly minor details may vary from the published ones, and these things will very materially change results. Costs of expensive methods of doing work, and even of mismanaged jobs are valuable, at times more so than exceptionable well-managed contracts, or jobs that are surrounded with most favorable conditions, as they may tend to set too low a price for work that on the surface may appear similar.

The following account of a month's work done in North Carolina, in the month of November, 1901, may serve to illustrate, as it was to a great extent a record-breaker, and was by far the best month's work done in nearly a year and a-half of work by three shovels. The writer trusts that the information given as to costs may be of benefit to others. The accompanying cut gives an idea of the work that had to be done, it being a cross-section of the cut at the deepest point. The old cut is in solid lines, the new cut is in dotted lines, and the hatched part is solid granite.

It will be seen that the work was done to reduce the grade and ease up the curve. The work on the right of the old track was excavated to the grade of the old track first, about 31,000 cu. yds. being moved to lay a temporary track to be used by the trains while construction was going on. When this work was being done the old track was used as a loading track. The solid rock made the progress of the work slow. Work was commenced on Sept. 5, and was finished Oct. 31, working day shifts only except during the last week of this time when both day and night shifts were worked. During that time 29,800 cu. yds. of earth and 1,200 cu. yds. of solid rock were moved.

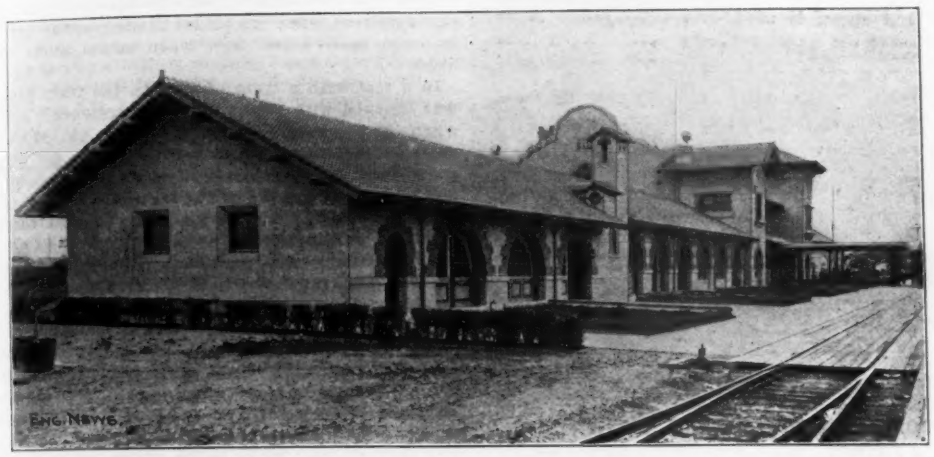
On Oct. 31, the shovel was moved to the other side of the cut and began to dig dirt that night. On this side it will be seen that the shovel was kept on top of the ledge of rock. The shovel worked on this solid rock bottom for nearly 500 ft. The cut was about 1,200 ft. long. Day and night shifts were worked during the whole month of November, the shifts relieving one another at 6.30 both night and morning, and seldom losing more than a few minutes in making the change. The main line was again used as a loading track. Work went on, no matter what the weather, but during that month the weather conditions were very favorable. The material was red clay mixed with mica, and could be classed as "average earth." The water in the ditch on the left-hand side of the cut was turned by track boxes to the other side. The bank ahead of the shovel was shot with powder enough to shake it up and prevent caving and was done so well that not more than five hours were lost by cave-ins on the shovel during the entire month. The width the shovel cut from the center of the loading track at the widest



CROSS-SECTION OF RAILWAY CUTTING.

point was 51 ft.; all of it was over 35 ft. The breast had an average height of 40 ft.

The shovel was a 65-ton Bucyrus built in 1901, and came to this piece of work new. The house was of steel; in fact, the shovel was entirely of steel construction and was similar to the model the Bucyrus Co. had on exhibition at the Pan-American Exposition. The boom had steam crowding engines on it, 14 × 14 ins., and the swinging engines were of the same size. The boiler was locomotive type, and was an excellent steamer. The dipper was speeded to four dips per minute, and it was rated at 2½ cu. yds. A Chase engine directly-connected with an Eddy dynamo supplied power for two arc lights hung on brackets on either side of the front of the house. An incandescent light was under the shovel in front and one in the rear. These were used to furnish light in moving the sectional track. One incandescent lamp furnished light to the fireman,



VIEW OF SOUTHERN PACIFIC PASSENGER STATION, SAN ANTONIO, TEX., LOOKING NORTH.

while one was on the switchboard. The fifth incandescent lamp was hung on a long cord in the center of the house, and when needed was moved around, and could be dropped under the center of the shovel to be used among the propelling gear. Each light when not in use could be turned off. The lights were arranged in three circuits, and each circuit could be cut off at the switchboard. The lighting arrangements were excellent and very conveniently arranged, and no trouble was experienced with lights being dim because of insufficient boiler power. At times the shovel was run when the boiler furnished power for the electric plant and furnished steam to an Ingersoll and Sargeant (3⅝-in. cylinder) drill as much as 100 ft. in front of the boiler. At other times while the shovel was running at nights and the lights were in use, a 4-in. steam siphon and a 1½-in. steam jet were run from the boiler, and used in pumping water from the pit. On the dumps Kitson contractor's lamps were used, burning gasoline. They gave excellent light but were easily knocked over and injured, and the mantels were used up quickly.

Two trains served the shovel. The locomotives used were Rogers' make, 16-in. cylinder, 51-in. driving wheels. They were built in the seventies, but both had come from an overhauling in the shop to this piece of work. The trains were made up of 15 Kilbourne & Jacobs 6-cu. yd. two-way dump cars, six cars on the end of each train having brakes. During the day the dirt trains ran in both directions from the shovel, one dump giving an average haul of a mile. The work on this dump consisted in widening and raising an old embankment 12 ft. The track raising does not enter into the cost of this work, as one gang dumped the cars and another gang raised the track, and for the latter work force account plus 10% was paid. The dumping gang consisted of one foreman and 20 men. To facilitate dumping the embankment was kept cut away from the end of ties as much as was consistent with the work that was being done. This allowed the earth to run out of the cars and down the sides of the embankment. The dump in the other direction gave an average haul of 2½ miles, and was a new embankment, made alongside of an old one, but 14 ft. higher. A temporary trestle was built here, one train using it during the day, while at night both trains made this their dumping grounds. A force of only one foreman and 12 laborers on a shift was found necessary on this trestle. The train was run out onto the trestle and stopped, and then the cars were dumped, after which they were run back onto the embankment and latched up. This mode of dumping prevented the earth from forcing the trestle down. The bents in this trestle were spaced 14 ft. c. to c., four posts to the bent, and were built of round pine poles, rough scored with an axe where one pole bore on another. The mud blocks, sills, posts and caps were all round timbers being at least 9 ins. at the small end. The bridge was well braced with 3 × 8-in. sawed pine braces put on with 9-in. ship spike. The posts were drifted with ¾-in. round iron to the sills and caps. The stringers were 10 × 12-in., 16-ft. long sawed pine, not drifted to the caps. Ordinary track ties were used. After the trestle was filled the track could be thrown to either side as desired, and the stringers were taken up to be used again. The top of the cap was made to conform to the profile grade, thus making an allowance on the embankment for shrinkage.

The yardage in this embankment was approximately 75,000 cu. yds., making a cost per cubic yard of the embankment for the temporary trestle of not quite 2 cts. In the writer's opinion this was a very low cost, and quickly paid for when one considers that 12 men did the dumping at this embankment, while it took 20 men at the other. The track laying on this dump was done by the dumping crew, with the help of the track gang, between trains, and track was laid clear across the trestle as quickly as possible.

One money-saving item of this work was that it was not necessary to lay a loading track in the cut, as the main line was used for the first two cuts, and the temporary track was used as a loading track for the third and last cut. This was made possible by the range of work the shovel permitted. The shovel gave a clear lift, without cribbing, of over 14 ft., cut 27 ft. from the center of the shovel, and dumped 24 ft. from the center. The total lift could be had only at the maximum dumping distance. For digging in close quarters short-armed jacks were used on the shovel, but wherever possible the regular jacks were used, as they were found much safer and gave far better service.

The dirt trains were operated entirely on the main line and the crews consisted of the engineer, fireman, conductor and two flagmen, all of whom had to pass the railroad company's examination for such positions. From 20 to 30 of the railroad's trains a day were run on the main line, there being four passenger trains and two fast freights. These trains had to be cleared on the time of the nearest station 10 minutes, while the rest of the trains could be flagged, but not delayed more than a few minutes. The dirt trains worked on "work train orders," received from the chief dispatcher each morning and evening, and a telegraph operators was kept day and night in an office near the shovel pit to give train crews orders and time on all trains. Taking to the side track for these trains played a prominent part in the amount of work done, and, of course, in the cost of the work. Fully 40% more work could have been done if the tracks had been clear at all times.

The following list gives the forces employed and the cost of the work for both day and night shifts during the month:

Camp Force and Superintendence:		
Engineer in charge		$150.00
Bookkeeper		65.00
2 clerks		85.00
2 telegraph operators "Board"		30.00
1 night watchman		35.00
2 cooks and 2 flunkies		165.00
Superintendent		140.00
Night superintendent		90.00
Loading Forces:		
2 steam shovel runners		280.00
2 cranemen		180.00
2 shovel firemen at $2.25 per day; 26 days		58.50
4 pitmen " 1.25 " " 26 "		130.00
6 pitmen " 1.00 " " 26 "		156.00
4 workmen blasting 4.25 " " 26 "		110.50
120 kegs black powder at $1.25		150.00
Dynamite, exploders, etc.		64.75
Hauling Forces:		
4 locomotive engineers		360.00
4 firemen		160.00
4 conductors		300.00
8 flagmen	$1.00 per day; 26 days	208.00
1 switchman	1.00 " " 26 " (night)	26.00
1 car oiler	1.00 " " 26 "	26.00
Dumping Forces:		
Day Dump—1 inspector		40.00
1 foreman	$3.00 per day; 26 days	78.00
20 workmen	1.00 " " 26 "	520.00
Day and Night Dump from Trestle:		
2 foremen	$2.00 per day; 26 days	130.00
24 workmen	1.00 " " 26 "	624.00
Miscellaneous Forces and Costs:		
Track Force—		
1 foreman	$3.00 per day; 26 days	78.00
10 workmen	1.00 " " 26 "	260.00
Extra Force—		
1 foreman	2.00 " " 26 "	52.00
10 workmen	2.0 " " 26 "	260.00
1 blacksmith	3.00 " " 26 "	78.00
1 " helper	1.25 " " 26 "	32.50
3 boys	.75 " " 26 "	58.50
Oil, gear shield, waste and packing		110.00
Torpedoes, fuses, etc.		12.50
Coal, 262 tons at $3.25 per ton		851.50
Repairs to shovel, engines and cars		285.00
36,000 cu. yds. at 1¾ cts. temporary trestle		630.00
Total		$7,069.75

The railroad company furnished to the contractor, free of cost, the necessary rails, ties, switches, track bolts and spikes. At the conclusion of the contract this track material was returned to the company and all shortage except on bolts and spikes was paid for by the contractor at the market price for such material. This is a very equitable method of handling such items of a contract, as the contractor would charge a much higher rate of interest on the money he would be compelled to invest in track materials if it was incumbent upon him to furnish them, than the company paid by furnishing such material itself. The railroad company also furnished the telegraph operators, and had an inspector on the work, whose duty it was to see that the chance of accidents was reduced to a minimum, and to protect the company's interest in every way, he paying special attention to track raising. The contractor, by special arrangements with the company and the men themselves, paid the inspector $40 per month in addition to the salary he received from the railroad company, and board was furnished to the operators. This was done to promote harmony and make these men feel that they were to work for the best interests of both parties. The scheme worked admirably.

The yardage moved by the shovel in this month was 56,120 cu. yds. This estimate was made by the engineering department of the railroad company after carefully running levels over the pit and plotting them on their original cross-section sheets, then making their calculations from these sheets. This gave the exact yardage, which fell considerably under the yardage estimated from the car records kept by the train conductors. The struck measure of a car was 6 cu. yds., and the cars were always loaded heaping, but the load averaged a little less than 5 cu. yds. in place. The price paid was 30 cts. per cu. yd., making a monthly estimate of $16,836 for work done. The average cost per cubic yard was 12.6 cts. Itemizing the cost under different heads we have:

Office and Superintendent	$0.014
Loading	.027
Hauling	.034
Dumping	.036
Miscellaneous	.015
Total	$0.126

In the cost of loading is included blasting, fuel

and oil used for shovel and repairs on same. In hauling is included repairs to locomotives and cars, fuel, lights, torpedoes, oils and other necessary items. The cost of the temporary trestle and lights is considered in dumping. In "miscellaneous" is put the cost of track laying, both in shovel pit and on the dump, pumping of water, also blacksmithing, and sundry items too numerous to mention.

The outfit used on this work cost about $27,000. Allowing 25% per annum as interest and depreciation of plant, we have a monthly allowance of $562.50, which will make a charge for this month of 1 ct. per cu. yd., making a total cost per yard of 13.6 cts., leaving the contractor $9,203.75 profit for the month.

The hard rock bottom that the shovel worked on during part of the month retarded the work somewhat, while the frequent taking of side track to let trains pass interfered with the work considerably. The swinging cables on the shovel broke twice during the month and several hours were lost each time in repairing. One bad cave-in on the shovel occurred, losing nearly half a day of shovel work by it.

The average yardage moved for each day was approximately 2,160, which makes 1,080 cu. yds for each shift. If it had been possible to keep cars to the shovel continually, more material than this could have been moved in 12 hours, but a shovel will never move the yardage at which it is rated. Working under the conditions cited in this article, 1,080 cu. yds. is a good day's work. Frequently 15 cars were loaded in 12 minutes, and as it took three dips of the shovel to load a car, four dips to a minute was approximately obtained. Working at a breast the height of the one here mentioned, 50 to 60 cars were loaded at one move of the shovel, and in this pit about three minutes were consumed in making a move of the shovel.

It may be of interest to state that it cost approximately $7,000 to move the 31,000 cu. yds. that were excavated by the shovel in September and October.

THE GRAND TRUNK PACIFIC RAILWAY, which is to be the new Canadian transcontinental railway, as described at some length in our issue of Oct. 22, 1903, is in the hands of the Grand Trunk Ry. Co., and active measures towards construction will probably be taken when Mr. Charles M. Hays, Second Vice-President and General Manager of that company, returns from Europe. The work of surveying the route is now in progress. The general scheme and organization for the surveys is in charge of Mr. J. R. Stephens, Assistant Chief Engineer of the Grand Trunk Ry., at Montreal. He has division engineers at North Bay, Winnipeg and Edmonton, with district engineers who are making the reconnoissance and running preliminary lines all the way from North Bay to a distance of some 150 miles northwest of Edmonton. Nothing has yet been settled as to the probable place and time of starting the construction.

THE EXTRADITION OF GAYNOR AND GREENE, the Savannah Harbor contractors who fled to Canada to avoid trial for conspiracy with ex-Capt. O. M. Carter to defraud the Government, has not been abandoned by the Department of Justice. Readers of Engineering News will recall that extradition of Gaynor and Greene was refused by Justice Caron, of Quebec, two years ago, on the ground that the extradition treaty with the United States did not provide for the crime of conspiracy to defraud. Appeal from this decision was taken by the United States to the Privy Council sitting in London and argument on the appeal is to be heard in February. The United States is to be represented in the case by Donald McMaster, Esq., of Montreal, and Sir Edward Clarke.

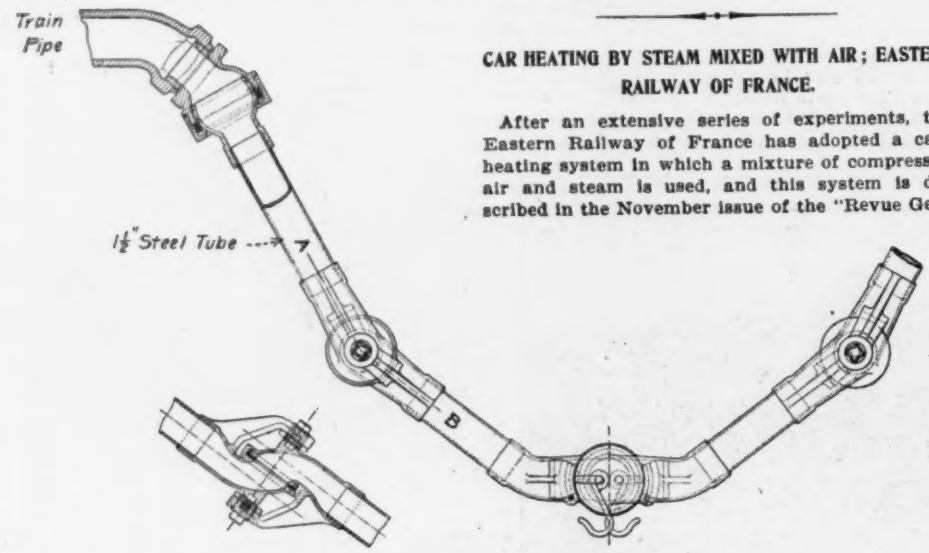


FIG. 1. METALLIC HOSE WITH FLEXIBLE JOINTS FOR STEAM PIPE FOR CAR HEATING; EASTERN RAILWAY OF FRANCE.

CAR HEATING BY STEAM MIXED WITH AIR; EASTERN RAILWAY OF FRANCE.

After an extensive series of experiments, the Eastern Railway of France has adopted a car-heating system in which a mixture of compressed air and steam is used, and this system is described in the November issue of the "Revue Generale des Chemins de Fer" by Mr. Lancrenon, Chief Engineer of Motive Power and Machinery of the Eastern Railway.

The subject of heating cars from the engine was first taken up in connection with the long suburban trains at Paris, where the use of portable foot warmers was a nuisance, and stoves gave rise to universal complaint. A system of steam heating then in use had iron cylinders in the car with a single opening for the entrance of steam, and the escape of water of condensation. This was not satisfactory and could not be used for trains of over 10 or 12 cars, while the suburban trains have as many as 24 cars, many of them being double-deck cars (with both decks enclosed). The steam-heating system was also objectionable in that it heated the air of the car without warming the feet of the passengers. On considering the problem, Mr. Lancrenon conceived the idea of using a mixture of steam with air from the brake pump and distributing this by a system of pipes with traps or blow-offs at the ends.

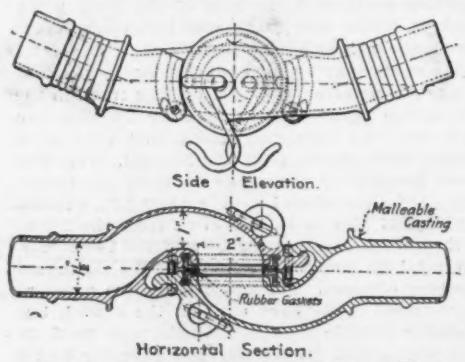


Fig. 2. Details of Coupling of Steam Pipe.

Along the whole length of the trains extends a train pipe, the admission of steam and air to which is controlled by the engineman on the locomotive. On each car the train pipe connects at the front end with a chamber from which run three small pipes, which are looped along the floors of the several compartments, and are covered with metal plates, these plates being put in front of the transverse seats, so as to form foot warmers. At the rear end of the car the pipes enter a chamber fitted with a trap to discharge air and the water of condensation. One, two or three pipes may be used, according to the severity of the weather.

With a long steam pipe closed at the ends by a trap, pockets of water are liable to occur and prevent the proper flow of steam to the end of the pipe, but by admitting a certain proportion of compressed air, the rate of flow is increased sufficiently to keep any water moving constantly towards the discharge end. This combination of air and steam has made it practicable to use long pipes of small diameter, laid horizontally, and having numerous elbows. As the car body tilts on curves, etc., these elbows form low points for the collection of water, and this gave rise to considerable trouble when steam alone was used, but since the adoption of the combination system no trouble has been experienced. Owing to the more rapid current, also, the initial heating of the cars is much more rapid than when steam alone is used.

In a test with a train of 19 cars, the train pipe was charged with steam at 8.8 lbs. pressure,* and when the pipes were filled and the cars heated the gage on the train pipe showed 1.65 lbs. All the traps were closed, only a little water escaping, and no steam was visible for the entire length of the train. Air at 8 to 10 lbs. pressure was then admitted, and in 30 to 40 seconds the gage on the train pipe showed a pressure which rose to over 4½ lbs. The traps then opened, discharging water in plenty and some moist air. This lowered the gage pressure to 3½ lbs., which remained constant. In another test with 30 four-wheel cars (130 compartments), it was not possible to fill the pipes when steam alone was supplied, and air at about 10 lbs. pressure was admitted. When the pipes were all filled and the cars warmed, the air was shut off, and with 4½ lbs. steam pressure at the head end, the pressure at the rear end was only 1½ lbs. Air at 10 lbs. was again admitted, when the gage rose to 3⅛ lbs., but when the traps opened it fell to 2¾ lbs.

For the train pipe coupling rubber hose and metallic tubes with flexible joints have been used, but the latter, shown in Fig. 1, have now superseded the rubber hose. The connections are of the type shown in Fig. 2. For coupling to the care of foreign railways, to the train pipes of freight cars run in passenger service (and having no heater pipes), and to the fixed steam pipes for heating trains at stations, a flexible tubing is used composed of spirally-coiled strips of steel, Fig. 2. These, however, are inferior to the metal tubing with flexible joints, Fig. 1.

Mr. Lancrenon states that the combination heating system above described has been adopted also for the Paris suburban trains of the Western Railway, and for the Paris-Bordeaux trains of the Orleans Railway. The system will be put in service on these lines during the present winter.

THE FAILURES AND THE POSSIBILITIES OF WATER FILTRATION.†

By Allen Hazen, M. Am. Soc. C. E.‡

Most of the filters that have been installed in this country have failed at times more or less. Some of them have failed habitually and disastrously. With others the failures have been occasional and slight, and some have not failed at all. By failing I mean that water has been sent out from them falling considerably short of the standard of purity established by reasonably well constructed and operated filters. This definition may be a little hard on some of the older plants, for nearly all of them have served to improve materially the quality of the water which has passed them, and to this extent they have been successful. I am considering the matter, however, from the standpoint of the most exacting requirements of the present time, and from this standpoint these plants cannot be considered as entirely successful. These shortcomings of filters have been widely advertised, and as I say, have greatly limited the extension of a most useful process.

*These pressures are presumably per sq. centimeter, but the article does not specify this. The gage pressures would then be about six times greater than those noted in the article.

†Abstract of remarks made at the Sanitary Conference of the Health Officers of Connecticut, at New Haven, Dec. 17, 1903.

‡Consulting Engineer, 220 Broadway, New York City.

Progress is often made by a study of failures, and I want to talk to you to-day about the reasons for these failures; and why, as I believe, the fact that there have been failures should not be given too much weight in considering the application of the process to new problems.

Let us consider briefly what the causes of the failures have been. They can all be divided into two classes, namely, those resulting from defective construction, and those resulting from defective operation.

Under the first head we have, first, the defective results which are obtained from filters of old designs. There are still in the United States many filters, built before the art of water purification was much developed in this country; and while some of these old filters were of surprisingly good design, considering the time at which they were built, and have been and still are doing good service, there are many others defective in important particulars, and so far failing to represent the conditions known by modern experience to be essential to success that the results obtained from them are very inferior. In some extreme cases the water is hardly purified at all, and the filtration might almost as well be abandoned.

As a second cause I will mention inadequate construction. By this I mean the cases where filters are provided of too small capacity for the work to be done, or where, in order to save money, the appliances provided are materially below those demanded by standard practice. This has been, and still is a very important element in unsatisfactory results from filters.

As a third cause we have the blind copying of designs successfully used elsewhere. There have been many failures in American filters coming under this class, that is, by injudicious applications of good designs.

As a last head under defects of construction, I place experimental construction; and this is by far the hardest one in the series to guard against successfully.

Nearly all filter designs are to some extent experimental. That is to say, it is seldom possible to reproduce a plant and all the conditions under which it operates in another locality. There is always something new, but the general practice of water purification has reached such a state that for a very large range of waters, a range so wide as to include most of the waters used for public water supplies in the United States, filters can be selected which so much resemble filters which have been successfully used for the same kind of water elsewhere that the experimental element in the construction is reduced to a minimum.

If all experimental construction should be shut out, the art of water purification would become stereotyped, and this is certainly not the result that we are looking for. But, on the other hand, it must be frankly admitted that a large part of the failures in water filtration have resulted from experimental construction.

The conservative and rational course seems to be to adopt in important new constructions only such improvements as are of a type to allow of very complete and certain analysis; and when it seems advisable to make other and more radical changes, the effects of which seem promising, but which cannot be told certainly in advance of trial, they should be used only in a small and tentative way, or they should be examined by experiment made for that purpose in advance of actual use.

When cities have built filters founded on entirely new processes, differing radically from the lines of approved practice, as a few cities in this country have done, the results in some cases, I think in nearly all cases, have been complete failures.

The second class of failures are those due to defects in operation. Of these many come from lack of proper attention. The filter is put in the hands of some one who does not understand it, or who does not know the importance of maintaining proper operation, and it is neglected at some time, or even habitually, and the results fall off in consequence. Sometimes the failure in operation comes from the desire to economize. This happens most frequently in those filters where chemicals are used as an aid to purification and where a direct saving can be made by using amounts of coagulant below the amounts necessary for the best efficiency.

I hope that I have made it clear to you that these causes of failure are precisely the same as those which cause failure in any undertaking, and that they can be eliminated and guarded against by the same kind of precautions that are necessary to success in any business.

The risk of using the water from a filter plant should be as little as the risk of traveling upon a train; in fact, it should be less, for the opportunities for control and safeguard are greater; and it can be arranged so that the chemist takes samples of water from a point entirely beyond the control of those in charge of the filters, and examines such samples so frequently as to enable him to detect any failure to accomplish the desired results from any cause whatever; and we may be sure that the man at the filters will not put himself in the way of being caught napping under such supervision.

Experience demonstrates that this can be accomplished. In Europe there are many filter plants operated on this basis. In this country there are few. From these plants water of the very best quality is uninterruptedly supplied year in and year out without a break, and with as little chance of failure as there is in the use of almost any appliance in common use. The number of such plants is increasing and will increase, and as time goes on, and as the subject is better understood, and is understood by more people, the plants that are insufficient, and badly designed, and inadequate because out of date, will be gradually replaced by better ones; and the superintendents and foremen who are not faithful and careful will be superseded by better educated and more careful men.

I want to emphasize to you to-day, gentlemen, that what is needed in water purification plants is not so much new processes and better processes as more careful and intelligent and faithful application of the processes that we now have.

The efficiency of filtration is well illustrated by the history of the water supplies of Paris and its suburbs in the last two decades. Paris has long had a supply of spring water, brought through aqueducts from distant sources—aqueducts comparable in their size and cost to those wonderful aqueducts which supplied ancient Rome. The quality of this spring water was regarded to be the very best. The unfortunate feature of the situation was that there was not enough spring water for all, and it was necessary to supplement the supply at times by pumping river water into the pipes. Typhoid fever was prevalent in Paris and was believed to be due to this mixture of river water.

FIG. 1. GENERAL VIEW OF NEW HYDRAULIC WORKS OF HENRY R. WORTHINGTON, AT HARRISON, N. J.
Bert. C. Baldwin & Co., New York City, Engineers.

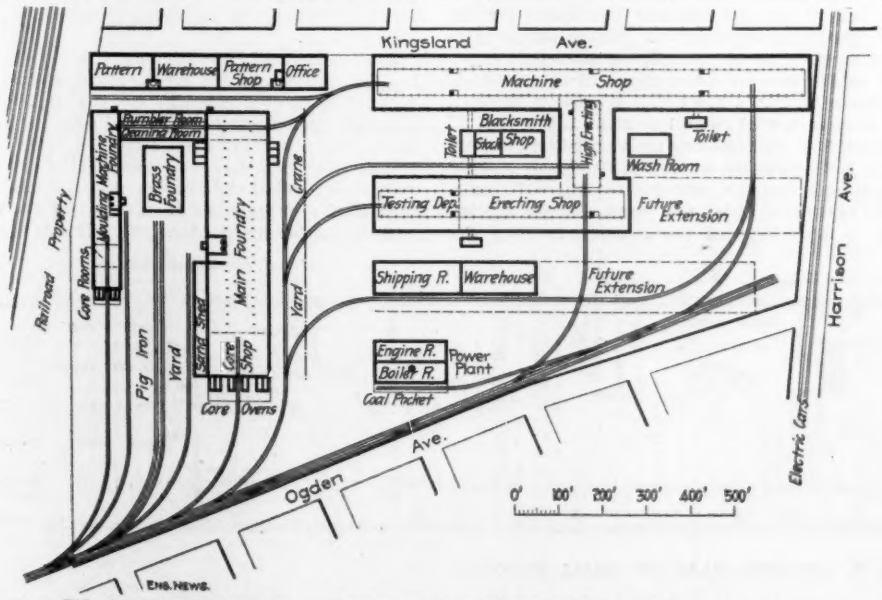


FIG. 2. DIAGRAM PLAN OF HENRY R. WORTHINGTON HYDRAULIC WORKS.

In 1893 Paris completed a new aqueduct, bringing in some entirely new springs of large capacity, and for the first time in a good many years there was enough spring water, and it was no longer necessary to pump river water into the pipes for domestic use. After this the typhoid fever rate in Paris decreased very rapidly. When Paris grew beyond its bounds, and suburbs developed with a population of several hundred thousand, these suburbs were not annexed because there was not enough spring water to go around; and Paris was unwilling to divide with them. These suburbs were entirely unable to secure a supply of spring water of their own. The next best thing available to them was to use the river water with filtration, and filters were established at several points by the company supplying them; and these filters were put in operation at about the same time that Paris secured sufficient spring water.

There were then these two bodies of population: Paris, the inner city, supplied entirely with spring water, and the ring of suburbs outside supplied with filtered river water; and it was soon noticed that typhoid fever was much less prevalent in the suburbs than it was in the city. Thus when the two kinds of supply were put to the ultimate test the filtered river water proved better than the spring water. For the last few years a commission composed of many of the leading scientists and engineers of Paris has been considering this question, and it has found pollutions entering the springs so numerous and so great as to amply explain the higher death rate among the users of this water. It has been possible to shut off some of these sources of pollution, and some of the springs have been excluded and filters have been built to make up the deficiency with filtered river water, and the conditions are thus improved, but the matter of entirely correcting them is difficult. It has been proposed to filter the spring water supplies, and other and new sources are under consideration, but no decision has been reached as yet.

At the present time there seems to be a sort of arbitrary standard in the methods of water purification. That is to say, methods are extensively used which make the cost of purifying a million gallons of water, including interest and sinking fund charges, somewhere in the neighborhood of $10, and which are sufficient to remove 99 or 99½% of the bacteria of the applied water. This may fairly be called the best practice to-day. A purification like this serves to furnish a water from the Merrimac, or from the Hudson, in every respect as good, and perhaps better, than is obtained from the best upland sources.

It would be difficult to produce sufficient reasons, and to back them up, to induce a water board or city council to

authorize the necessary expenditure to produce a much more complete purification than this, but it is important to keep this matter in sight, and to note that, if the pollution of our rivers increases, the purification can be made to keep pace with this increase, and it will be possible to obtain water of the best quality, even though conditions become far less favorable than they are to-day.

The triumphs in the past have been great. The typhoid fever death rates in a number of cities have been reduced by the installation of filters by 70 or 80% or more. The general death rates have also been reduced by amounts which correspond to much more than the reduction in the typhoid fever rates. Perhaps the achievements of the future in this respect will not be more striking than those in the past, but this certainly is true, that with the gradual raising of the standards of the quality of water supplies, and with the growth of a desire for cleaner and purer water, the art of water purification will advance and its application will be constantly extended, with the greatest benefit to the people of our cities.

THE NEW WORTHINGTON HYDRAULIC WORKS AT HARRISON, N. J.

One of the latest of the old-established manufacturing plants to be removed from New York city to suburban quarters, where its long cramped growth will be amply provided for, is the hydraulic works of Henry R. Worthington. The old Worthington plant at Brooklyn was built many years ago and has been added to from time to time until the entire available property is covered with buildings. Indeed, the plant reached this limit to its growth some years ago. Then the foundry was removed to Elizabethport, N. J., and the space occupied by it was given up to an extension of the machine shop. This move gave

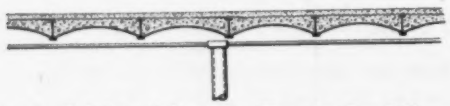


Fig. 4. Reinforced Concrete Floor for Small Foundry.

only temporary relief from crowding, and meanwhile other objections to the old plant with its distant foundry began to develop and call for remedy.

All castings had to be conveyed by lighters from the foundry at Elizabethport to the Brooklyn shops, and in case of flaws developing in the castings they had to be returned over the same slow route. These conditions urged the necessity of constructing a new plant at some point where there was ample area for enlarged works, and where everything could be placed under one management. The property chosen as meeting best these conditions is located at Harrison, N. J., and not more than one mile from the business center of Newark. This was the largest tract of unoccupied land near New York, that was at the same time well above high tide and provided with good connections with the various railway systems.

Turning now from general considerations to an account of the plant itself, it must be noted first that it comprises buildings and full equipment for manufacturing all sizes and classes of Worthington hydraulic machinery. It is also all laid out and constructed so that every building can be extended whenever the demand may arise for still more space than is now available. No portion of the works is distantly separated from the remainder, as was formerly the case, and most elaborate arrangements have been made for the intershop handling of materials and work. Finally, the structural work of the plant is now rapidly approaching completion. Fig. 1 is a general view of the plant made from a wash drawing.

GENERAL PLAN OF PLANT.—The general arrangement of the new Worthington plant is shown by the diagram plan, Fig. 2. The plant occupies a trapezoidal tract of ground of about 30 acres area, along the broad end of which are the railway lines entering the town. As will be

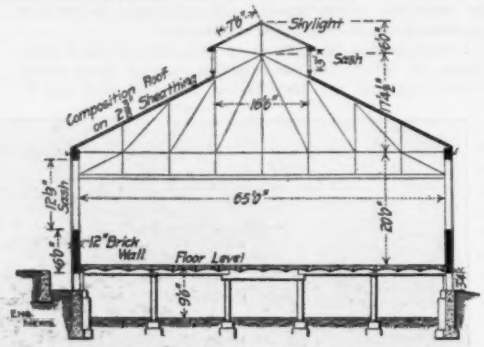


Fig. 3. Transverse Section of Foundry for Small Castings.

observed, the buildings are divided into two groups. One group comprises the pattern shop and foundries; the other group contains the machine and erecting shops and the warehouses. A system of yard tracks connect these buildings in group and individually with each other and with the railways. All handling of work within the buildings is accomplished by cranes, and for transportation from one building to another the yard tracks are employed. The transportation arrangement needs no further explanation. The plan also gives the names and dimensions of the several buildings, so that these features need not be explaned here. All buildings are constructed with steel frames and brick walls, with the exception of the pattern building, which is slow-burning timber construction. It is, perhaps, worth while also to call attention to the large size of the main buildings, before taking up their description individually.

FOUNDRY FOR SMALL WORK.—The first building to call for particular attention is the smaller of the two iron foundries which is to be used for small work. A diagram cross-section of this building is shown by Fig. 3, and from this drawing it will be observed that the foundry is built with a basement below the molding floor or foundry floor proper. This unusual arrangement and the appliances in connection with it are the features which call for the most particular explanation. Before referring to them, however, a few words are needed in reference to the general construction of the building. As shown by Fig. 3, the building consists of 65-ft. roof trusses carried on wall columns and spaced 12 ft. apart. The wall columns are carried on concrete walls, with pilasters at the columns, all resting on concrete footings, which form the side walls of the basement. Above the foundation walls, brick work is filled between the columns forming the wall of building. The intermediate support of the foundry floor consists of cast-iron columns rising through the basement story and the floor itself consists of reinforced concrete arches sprung between I-beams, as shown by the part transverse section, Fig. 4. The roofing consists of 2¼ × 8-in. nailing strips on the top chords of the trusses, which carry 2⅜-in. tongue and grooved yellow pine sheathing covered with "composition" roofing. The other general structural details call for no mention.

The cross-section of Fig. 3 shows a craneway suspended from the truss. All but nine of these trusses, these nine coming over the core rooms at the east end, have these craneways. Except for the two endmost trusses, they are constructed as shown by Fig. 5, which gives all the details plainly. The travel on these craneways is of course across the building.

Turning now to the special features mentioned above, reference will first be made to the general foundry floor plan, Fig. 6. On this plan the dotted lines show the molding machines and the shafting and machinery used in connection with them should it be decided to use these devices at any time, although at present it is probable that each sand elevator will be operated by an independent electric motor. Considering, first, the foundry floor, it will be seen that the east end for a length of 108 ft. is devoted to rooms for core-making, with core-drying ovens attached. Somewhat more than half of this section forms a special room for the girls employed in making light cores, and has a balcony floor on each side for storage. A standard gage track enters this end of the building and is carried on plank flooring with trap doors, by means of which molding sand brought in in cars is dumped into the basement. This standard gage track has a mid-

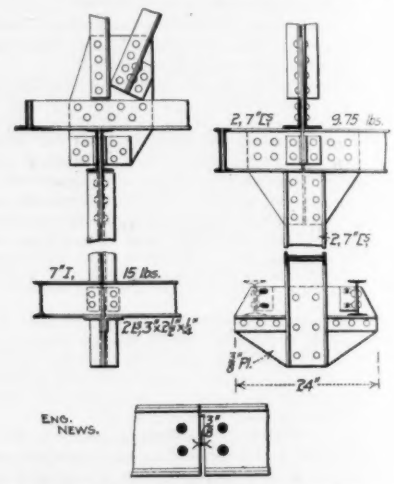


Fig. 5. Detail of Craneways for Small Foundry.

die rail, making a 30-in. gage track which is continued through the building, as shown by the broken lines.

The remainder of the foundry floor, except that portion occupied by the cupola room, is constructed with a pair of gratings in each bay. These gratings open into the basement and their purpose is to allow the sand from the flasks to be dumped directly into the basement after each cast, thus leaving the foundry floor entirely clear from sand and from the operations incident to its preparation for the molders' use. This sand when

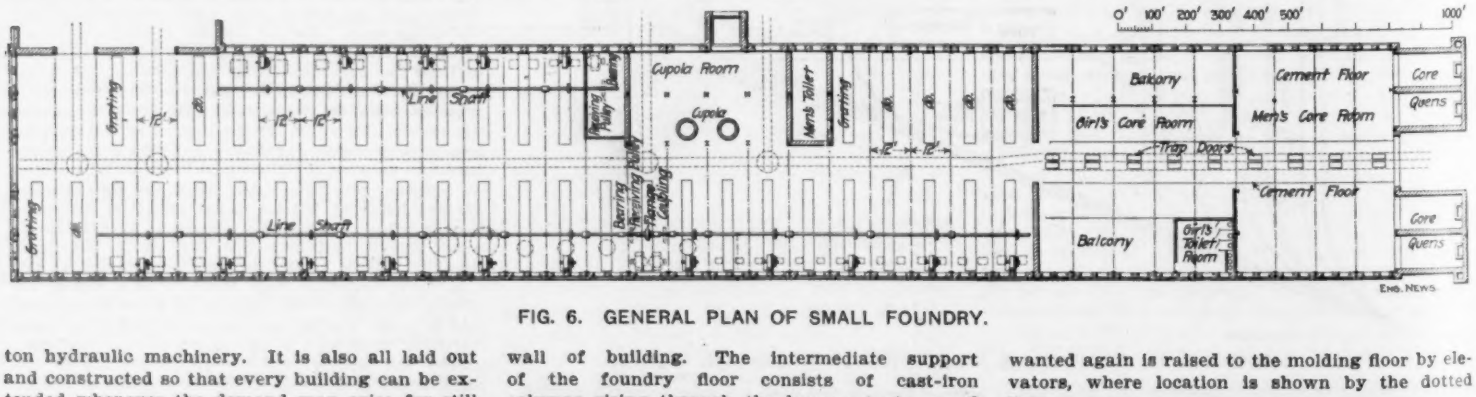


FIG. 6. GENERAL PLAN OF SMALL FOUNDRY.

wanted again is raised to the molding floor by elevators, where location is shown by the dotted lines.

The two details which are of interest in connection with the handling of the sand are the grating construction and the construction of the elevators. The grating construction is clearly shown by the drawings of Fig. 7. A grating frame of angles is carried on the floor beams, and in

turn carries sections of grating made of ¾ × 2½-in. bars fastened together by end rods and spacers. All dimensions are given by the drawings. The general arrangement of the elevators is shown by Fig. 8. As will be seen, the elevator is of the ordinary bucket type with a boot into which the sand is shoveled at the basement floor and with the usual hood and casing. The sand will be discharged into a reservoir hopper, from which the molders will draw it as needed.

MAIN FOUNDRY.—The main foundry is located parallel to and 200 ft. away from the small castings foundry, and the two are connected at the west end by a cleaning shed containing a cleaning room and a rambler room. The cleaning floor of the main foundry is continuous with this cleaning shed. At the east end of the foundry is the core shop, with adjoining core ovens. Other core ovens are located on the sides of the building at the west end and a sand shed occupies a lean-to on the south side. The cupola room is at about the middle of the south side of the building. Structurally the main foundry consists of a center bay under a peaked roof and two side bays, with lean-to roofs. The center bay has a clear height of 36 ft. 8 ins., and the side bays are each 20 ft. high in the clear, and the building is amply lighted by skylights and side windows. The foundry is unusually well provided with cranes. There are bridge cranes in the side bays. The center bay has a heavy bridge crane, and in addition traveling jib cranes on each side. The arrangement of these traveling jib cranes is shown by Fig. 9, which needs no special explanation.

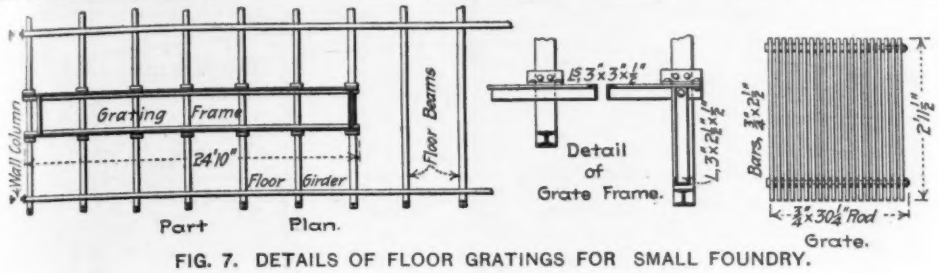


FIG. 7. DETAILS OF FLOOR GRATINGS FOR SMALL FOUNDRY.

PATTERN SHOP.—The pattern shop is located west of and close to the foundries. It is a four-story building of slow-burning construction, and is the only timber building on the plant. The building is 552 ft. long and is divided into four sections by brick partition walls. Two of these sections at the south end are pattern warehouses, another is the pattern shop proper, and the last, at the north end, is occupied by offices and the drawing room. The outside walls and partition walls are brick masonry, but the remainder of the building is slow-burning mill construction. As drawings of the most recent practice in slow-burning timber construction are not frequently published, we give some of the details of this work here.

Fig. 10 is a transverse section of the building through the pattern shop, close to the middle partition wall, which is shown in elevation. The column spacing across the building is uniform from end to end, but the longitudinal spacing of the columns varies, being 20 ft. in the office portion, 15 ft. in the pattern shop, and 10 ft. in the pattern warehouses. The drawings of Fig. 10 are so complete that practically the only details that call for special attention are the post caps and the bearings of the floor girders on the side walls. The post caps are cruciform pedestals of cast iron of the general form and construction shown by Fig. 11. These caps are inserted between stories, and their purpose is to give the floor beams connection with the columns and at the same time make the column continuous from floor to floor. Where the post takes the rafter use is made of the special caps shown in Fig. 12, and at the bottoms of the columns are used base plates constructed as shown by Fig. 13. Details of the wall connections for the girders and rafters are shown by Fig. 14.

Over the office portion of the building the peaked roof shown by Fig. 10 is replaced by a saw-tooth roof to give light to the drawing room on the top floor. There are five bays of this roof, each bay running transversely across the building and consisting of two wall trusses and three intermediate trusses carrying purlins and roofing. The drawings of Fig. 15 show these trusses and their connections, and need no explanation.

MACHINE AND ERECTING SHOPS.—Structurally the machine shop and the adjoining erecting shops are practically one building. The machine shop and erecting shop are identical in construction, and the high erecting shop differs from them only in having two more stories. The end view, Fig. 16, gives an excellent idea of the steel work for the machine shop. As will be seen, there is a bridge craneway in the lower story of each side bay and another in the center bay. An interesting feature of the main column construction is the omission of the lacing and insertion of a plate and angle seat just above the craneway brackets for the side bays. The hole and seat thus provided will accommodate the line shafting. The main erecting shop is identical in construction with the machine shop, and Fig. 17 shows the construction of the high erecting shop. The center bay of this shop has a clear height of 71 ft. 10 ins. from floor to bottom chord of roof truss. The corresponding dimension of the machine and erecting shops is 39 ft. 7¼ ins. The craneways of the high erecting shop are 62 ft. 1⅜ ins. above the floor, and those of the machine and erecting shops are 29 ft. 10⅜ ins. The wall and roof construction of these buildings is the same as that of the foundry buildings.

MINOR BUILDINGS.—The minor buildings of the plant do not call for particular description. They are all brick wall and steel frame structures.

The workmanship and material employed call for no particular mention, they being such as are usually demanded in first-class structural steelwork and building construction. The plant was designed by Mr. Bert. L. Baldwin, Engineer, New York city.

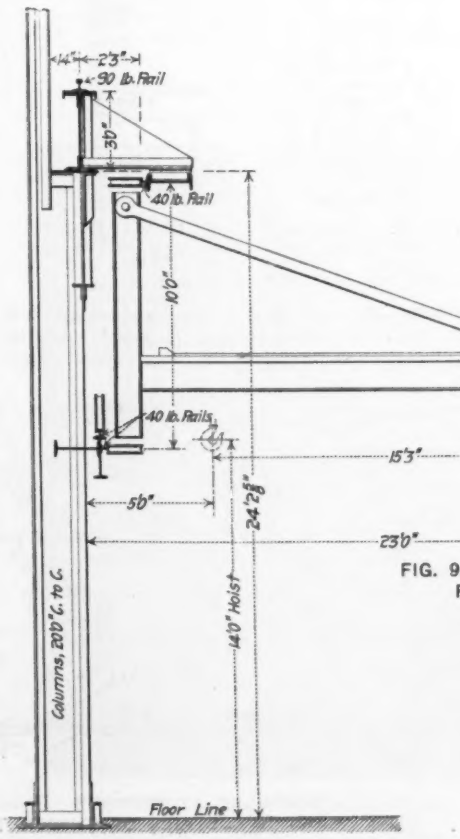


FIG. 9. TRAVELING JIB CRANE FOR MAIN FOUNDRY.

MEASUREMENTS OF ELECTRIC CURRENTS ON GAS AND WATER PIPES IN GENEVA, SWITZERLAND.

The city of Geneva, Switzerland, operates a municipal water-works and a municipal gas plant. The street railways in the city and suburbs are operated by a private company, but current is supplied from a municipal power station. These railways use the overhead trolley exclusively, the return being through the rail. The network of

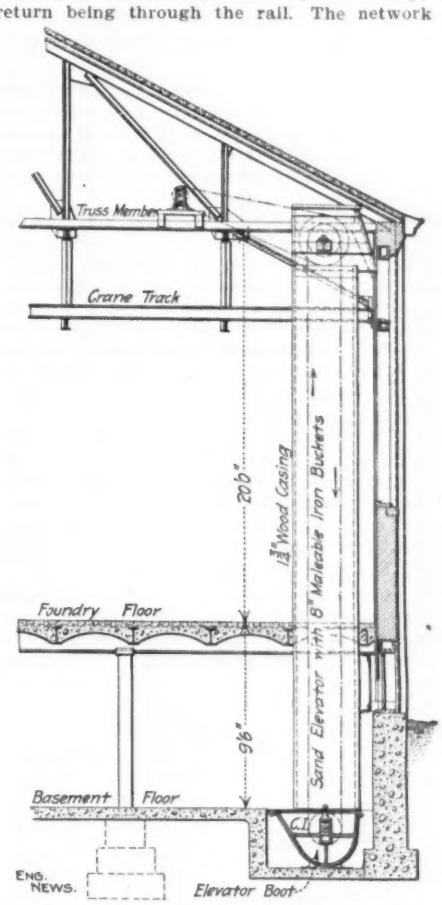


Fig. 8. Sand Elevator for Small Foundry.

rails, consisting partly of girder rails and partly of T-rails, varying in weight from 40 to 90 lbs. per yd., is solid bonded throughout. The rotary converter station, where the direct current for the trolley supply is produced, is located in the pumping station of the water-works; the gas plant is a short distance away. The gas and water mains, therefore, are virtually paralleled by the rail network.

To determine whether the conditions presented any danger of electrolysis of the pipes, an electrical survey of the city has recently been made, whose results are briefly noted in the following:

The Geneva street railway system has the rails connected to the positive pole of the dynamo, while the negative leads go to the trolley wire. The current goes to the rails by way of several copper cables, the main one of which is a bare copper cable about 2,370,000 circ. mils in cross-section and about 500 ft. long. From the point where this feeder connects with the track to the focal or branching point of the railway network there occurs a voltage drop of about 2 volts in the rail. This is increased to an average of 3 volts at a distance of 1 to 1½ miles from the station, which distance may be considered the boundary of the inner or urban network. The suburban lines run out as far as 10 miles from the station in one case. Naturally the rail losses on the outer lines are much greater than in the urban network, the more as the track rails there are much lighter; the maximum drop in the rail is about 19 volts from the power station.

The potential difference between rails and gas

or water pipes was measured at as many points as practicable. In general the pipes within the inner district are negative to the rails, the average potential difference being 0.2 to 0.3 volt, rising to 0.8 volt as the ordinary maximum. An exceptionally high potential difference was observed in the region embracing the power station, the rail feeder connection, and the branching point of the network. At the power station there was 4-4.5 volts from positive busbar to water pipes. Along the rail feeder connection the voltage from rails to pipes was 2-2.5 volts.

Outside of the urban portion the pipes were found to be positive to the rails, with values increasing up to a maximum of 11 volts at the end of a particular suburban line. In general no difference was noted between gas pipes and water pipes as regards electrical topography.

Current measurements on the pipes, made by the shunt method, showed that currents radiate outward from the vicinity of the rail feeder connection. From 3 to 8 amperes was found on the various pipes in the neighborhood of the power station. As an experiment, the water pipe system was electrically connected to the positive busbar at the power station switchboard; the currents in the pipes jumped to about five times their previous values, or up to 32 amperes in a particular 20-in. pipe. The current in the experimental connector to the pipes was directly proportional to the total load on the station; thus when the load was 1,000 amperes the current in this connector was 140 amperes. When so connected, the pipes were no longer negative to the rails in the urban district, but were positive throughout.

Current measurements on the outer lines showed that the stray current varied greatly with the movement of the cars. An interesting experiment on this point is summarized in the table below.

Fig. 11. Details of Post Cap.

Fig. 12. Details of Post and Rafter Connections.

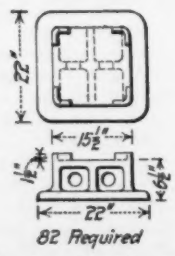


Fig. 13. Details of Base Plate for Posts.

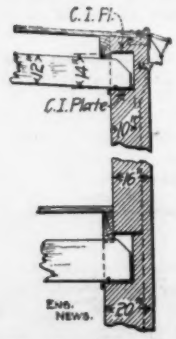


Fig. 14. Wall Connections of Timber Girders and Rafters.

The rails of the track were disconnected at one point and a calibrated low-resistance shunt inserted. Voltmeter readings on this shunt gave the current in the rails. A single car was placed at varying distances beyond this point and arranged to draw about 100 amperes from the rail, while standing still. The current in the rail at the point of measurement, and the current on the car were measured. The difference was the stray current at the point of measurement. The table shows that this current is a very large percentage of the total current.

Distance car beyond point of measurement.	Current, Amp. Car.	Current, Amp. Rail.	Stray current. Amp.	Stray current. % of total.
33 ft.	85	45	40	47
985 "	100	50	50	50
3,900 "	100	52.8	47.2	47.2
13,000 "	95.5	37.6	57.9	60.7

Current measurements directly on the pipes were more difficult on the outer lines than on the inner. A few which were made on 4-in. pipes showed only small currents, up to 1 ampere. As already noted, the pipes are positive to the rails in the suburban district.

Mr. L. Thormann, of Zürich, who conducted the tests and describes them in the "Schweizerische Bauzeitung," concludes that within the central district, where the rails are positive to the pipes, there is no danger of electrolytic corrosion. In the outlying districts, however, there is danger of such corrosion in the pipe system, since here the pipes are positive to the rails and also large differences of potential occur.

It is proposed to reduce the voltage drop near the power station, and thereby decrease the large currents in the pipes at this point, by more direct feeder connection from the busbar to the branching point of the track. For protecting the outlying districts from danger of corrosion it has been suggested to reverse the polarity throughout the system. The outer lines would then have the rails positive to the pipes, so that the latter would be protected from corrosion; the inner district would have the pipes positive to rail, but it is thought that the potential differences here can be kept small enough to avoid danger of electrolysis. Experiments are now being made to determine how completely this plan would solve the problem.

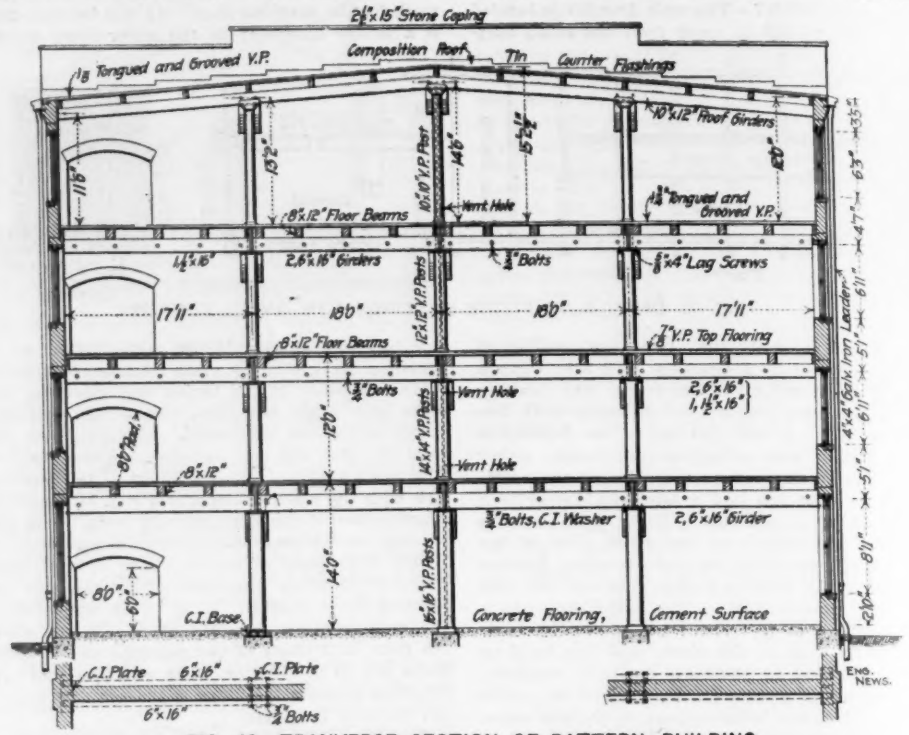


FIG. 10. TRANVERSE SECTION OF PATTERN BUILDING.

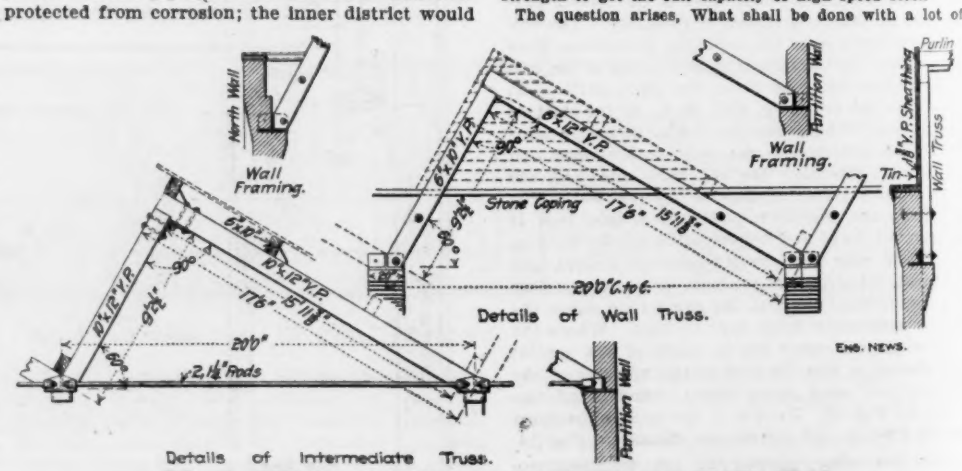


FIG. 15. DETAILS OF TIMBER TRUSSES FOR SAW-TOOTH ROOF.

INCREASING THE SPEED AND OUTPUT OF MACHINE TOOLS.

At the December meeting of the Western Railway Club, at Chicago, two papers were presented dealing with this subject. We give below abstracts of both these papers:

MACHINE TOOLS AND HIGH SPEED STEEL.
By J. A. Carney.*

Since the discovery of the self-hardening steels and the high speed steels, which require to be run at a high temperature for best results, and will do an amount of work impossible with carbon steels, the machine shop superintendent has undertaken to increase the output of his shop by speeding up the machinery and taking heavier cuts. But he has met with serious obstacles from the fact that the machines will not stand the strain necessary to get maximum results from high speed steel, and either the machine stalls or some part gives way. It is a fact that no machine shop is to-day fully equipped with machine tools which can use high speed steel to the limit of its endurance, nor are machine tool makers prepared to-day to furnish all classes of tools capable of obtaining maximum service from high speed steel. It is not claimed there are no machine tools which will do this, but they are a small minority.

In getting bids on lathes and planers it was specified that the lathes should cut ½-in. with ½-in. feed 30 ft. per minute, and the planers cut ⅝-in. with ½-in. feed 30 ft. per minute in mild steel. One maker said there were no such tools made, but that they could be made at an increased cost of 50% of the market price of standard machines. Machine tool makers to-day are only commencing to build tools of the necessary weight and strength to get the full capacity of high speed steel.

The question arises, What shall be done with a lot of serviceable machines which are not exactly out of date, but which cannot keep up with the high speed steel pace? In a great many cases they can be speeded up and with

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FIG. 16. VIEW SHOWING STEEL FRAMEWORK OF MACHINE SHOP.

moderate cuts the output of the tool largely increased, but it is found that the belting commences to give out and cast-iron gears break. It is possible to replace cast-iron gears with steel, but it is very probable that some other part will be unable to stand the strain and the machine will be wrecked.

The effect of belting with increased speed and cut on old tools is most disastrous, and if a tool is worked to its capacity the cost of repairs to belts and purchase of new ones will increase as much as 100%. The belts, if single ply, can be replaced with light double ply at a slight increased cost and an increased service greater in proportion, and in some cases it may be found economical to equip the machine with new cones, taking a wider belt.

The possible time saving of high speed steel, used with old and weak machines, is due to the fact that it will do much heavier work without regrinding and will finish most jobs without having to stop the machine and grind the tools. This item is a most valuable one and will do nearly as much to help a good output as the increased speed and cut. A driving-wheel lathe was speeded up so high that the tool steel used at the time would not stand the strain put upon it, and nearly as much time was spent dressing and sharpening tools as was used in turning tires. With high speed steel this lathe is in continuous service, but cannot pull as much as the steel is capable of cutting.

Where the output of a tool is in such demand that it is worked to its limit of capacity, and to increase the output of the shop would mean the purchase of a similar tool, it will pay to get rid of the original tool and buy a machine of up-to-date design, capable of maximum effort as counted to-day. The single tool of modern design will more than make up its cost in the extra work done. Where a tool is not kept busy all the time it may not be advisable to spend money where increased capacity would mean increased idleness; but even then there would be an argument of cheaper work on account of the faster output.

Increased speed can be obtained in most cases by increasing the speed of the countershaft, but great care must be taken not to tax the old tool beyond its endurance, or a series of annoying and sometimes expensive breakdowns will result. It is impossible to give any rule for scrapping or rebuilding old tools, because the conditions of each shop are so different, and a tool that is very nearly worthless in one shop may be a valuable adjunct to some other shop. As a general proposition, it is advisable to purchase a new tool if it can be shown that 20% of its cost can be saved per year over and above the output of the old tool.

The education of the old-time slow-speed tempered-tool machinist is no small item. This can only be done by intimate personal supervision, and it takes time to get him out of the rut of using 1-32-in. feed and 1-16-in. cut.

Up to the present time high speed steels have not given much success in fine work where a heavy cut cannot be taken, nor do they make good finishing tools. The reason is that the high temperature of the point of the tool necessary for good work cannot be maintained on fine cuts, and also when maximum work is being done by the tool the cutting edge is somewhat blunted and does not make a smooth job.

Among the economies brought out by the advent of high speed steel are the following: Forgings do not have to be finished so closely to make them work up economically, resulting in cheapened cost of blacksmith work; harder cast-iron can be used, resulting in greater wearing qualities; tires can be turned with a minimum loss on account of being able to cut closer under the skin.

The output of the shop equipped with old tools can be increased to a considerable extent by speeding up the machinery; but the makers of machine tools have had to wake up to the fact that heavier and more powerful machines must be made to keep up with the working capacity of high speed steel, and I venture to prophesy that heavy machinery is as yet in its infancy.

THE RATING OF MACHINE TOOLS IN LOCOMOTIVE MACHINE SHOPS.

By J. F. De Voy.*

The introduction of new machine tools and of new tool steel has increased the output of new work to such an extent that many of us are unable to determine exactly what can be done in the manner of machining parts and the best way to handle the same, and the object of this paper is to establish by a system of cards, 6 x 4 ins., information relative to the number of cuts, length of time and general movement of work to be performed. The idea of tabulating work at the different machines suggested itself from tests of a 100-in. wheel lathe in turning tires, a 76-in. boring mill for boring the above, a 26-in. axle lathe, several 37-in. mills used in driving-box work, and a 42-in. wheel lathe in turning steel-tired wheels, the results of which are tabulated in the manner indicated on the cards.

Referring to the accompanying copy of the proposed card, it will be found that it is possible to turn a pair of 84-in. plain tires in 2½ hours, and that a cut 5-16-in. deep, with feed of 5-16-in., speed 18½ ft. per minute, taken across a 6½-in. face, required 1 hour and 3 minutes for the roughing cut. The finishing and handling of this pair of tires required 1 hour and 27 minutes, making a total, as above stated, of 2½ hours to turn the tires. The total weight of metal removed per hour in roughing cut was 291.6 pounds. This is an actual performance. The average time, however, is about 3½ hours.

Another card shows that a driving box for a 9-in. journal can be faced on both sides and counter-bored for babbitt on a 37-in. boring mill in 2 hours; then taken to slotter and slotted ready for brass and cellar in 2 hours; then brass is roughed out and fitted to box in 25 minutes at 37-in. boring mill; then brass is taken to shaper, which finishes the edges in 25 minutes, and is finally inserted in box in 30 minutes, after which box is taken to babbitting room. Time for removing to mill and babbitting, ½ hour; from babbitting room to planer and fitted for shoes and wedges requires about 1.7 hours per box; then cellars are fitted at shaper in 2½ hours; then it goes to drill press, where 1 hour is consumed in drilling, and finally it is fitted for journal at 37-in. boring mill in 45 minutes. The planing hours per box were taken from a test of 24 boxes, which were handled and planed in 41 hours, but all the other work was figured singly. This entire work is all

EXAMPLE OF CARD FOR THE RATING OF MACHINE TOOLS.

Size, Ins.	Name of Part	Kind of Work	Time	Average Cuts	Feed	Depth of Cut	Cutting Speed, ft. per Min.
New 100 in. Wheel Lathe							
62	1 Pair Flange Tires	Roughed and Finished	3 hrs.	2	5/16"	5/16"	18½
84	" " Plain "	" "	2 hrs. 30 min.	2	"	"	"
56	4 Pair Tires	" "	9 hrs. 26 min.	2			
84	Plain Tire	Bored	30 min.	2			
56	" "	Roughed and Finished	2 hrs.	2	5/16"	¼"	16
Old 76 in. Wheel Lathe							
62"	2 Plain Tires	Roughed and Finished	5 hrs.	2	1/16"	¼"	16

FIG. 17. VIEW SHOWING STEEL FRAMEWORK OF HIGH ERECTING SHOP.

*Mechanical Engineer, Chicago, Milwaukee & St. Paul Ry., West Milwaukee, Wis.

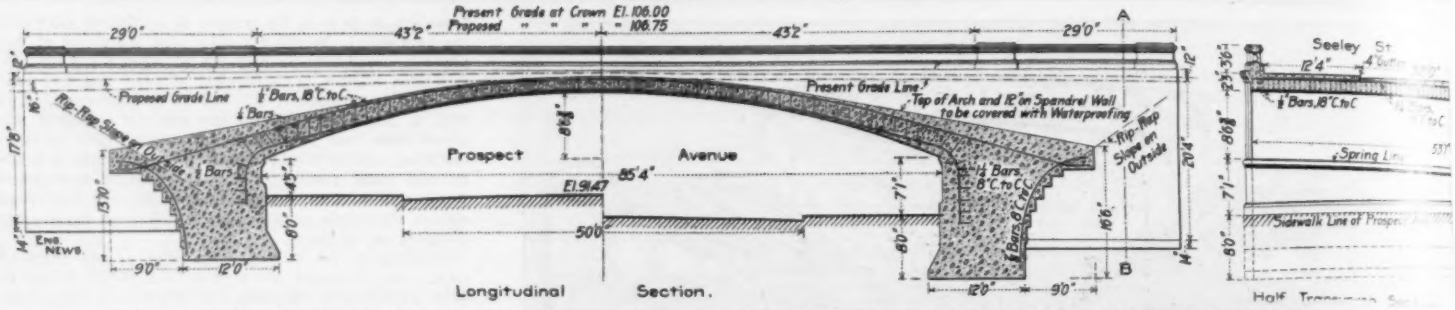

FIG. 1. LONGITUDINAL AND HALF TRANSVERSESECTION OF SEELEY ST. REINFORCED CONCRETE BRIDGE, BROOKLYN, N. Y.

done in floor space 66 × 50 ft., and in a total time of 11 hours and 47 minutes per box. In the space above referred to are one shaper, four boring mills, one planer, one drill press, one slotter, one drop press, babbitting fire and tools, and four air hoists.

A third card shows that a pair of 38-in. steel-tired engine truck wheels can be got out in 1 hour and 50 minutes. This time is an ordinary performance; four pairs being turned out in 7 hours and 20 minutes every day, and many times a good start is made on the fifth pair; one roughing cut 5-16-in. deep and 1-7-in. feed taken across face of tire and on outer portion of flange, then a finishing tool shaped as per standard contour and full width of face of tire, to finish. The first objection is yet to be heard from workmen in timing or regulating work in the manner indicated. Place a reasonable time limit on any piece of work, men to get it out in that time, and establish a method by which the work shall be done, it being assumed that men are paid the highest possible rate of wages, and if such is the case there can be no valid objection to any machine doing all that belts will drive and steel will stand to a reasonable degree.

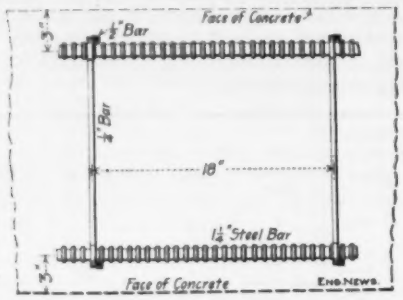

Fig. 2. Sketch Showing Connection of Tie Bars Between Upper and Lower Nettings.

It has been truly said that the time lost by the improper methods of chucking work would in many cases more than counteract any time gained by proper feeds with high-grade tool steels, and it is with the object of rectifying this mistake that up-to-date roads keep their tool department busy planning and making "short cut" tools.

Objections to tabulating cards are raised by many because of the possible fallibility of information and differences of opinions on the work movements. Now, this item in that it shows up in the clearest manner possible the remarkable increase in output by strictly modern machinery over that of an earlier date. An example is found in the wheel lathe tests, where we find that the new lathe will easily turn out work in 3 hours which would require the old machine 5 hours; also that the new steel tire lathe will turn out work in 2 hours which took an older tire lathe 3 hours to do. One new 30-in. boring mill will turn out and rod bushings in 3 hours; the time the older machine took was 6 hours. The card system proves a valuable index in the purchase of new machine tools, giving the scope of work and the saving effected by same. In the comparison of cards between employees of a road, or between roads, discussion should produce beneficial results. In contract shops the card system is not at all new, and speed bosses, whose business it is to set a speed and feed for all kind of work, and adjust the respective cards, hold an important position in shop management. The chief benefit to be derived from a system to my mind is, as was stated above, in a clearer and more general knowledge of what our machines can do.

To one making out a table of tests, the fact that high-grade tools will crumble or break off a cutting edge with but half the cut, or even less, in an old machine, with every other condition identical, cannot be overlooked. The lost motion in an old machine is not a lost motion, but a burning motion, in its telling effect on roughening and shaping tools. This should and does affect the character of the work, and it is desirable to keep up a first-class character of work. An important consideration greatly affecting machine output, and very troublesome, inasmuch as it is a variable to a greater or less degree, is the amount of stock to be removed. In castings we find this in its less degree, and in small forgings it is not immoderate, but when we finally hit on the greater degree, in the familiar form of a frame, an axle or main rod, we feel that we have come to a guessing point. This is the reason why frame and rod work cannot be definitely calculated except in the speed and cutting list. Some of the new machines have done very good work on these parts which would not be recognized by outsiders in a card system.

The table of speeds and cuts is prepared from daily performances, and not, as in some tables, from tests of about an hour's duration, and are intended to keep the tool in good condition without grinding.

It is believed that nothing has more materially helped the output of drill presses than the table of speeds, etc., which has been placed on up-to-date machines by several shop foremen. By referring to these tables it can be ascertained at once the best results which can be obtained with any size of drill, and how many men really know how fast a drill can be driven on different metals unless a special table is prepared for them?

The tables do not venture to affix prices, as is done in both piece work and reward systems, for cost of material and labor are subject to change, and it is not the object of this paper to favor either one or the other.

A CONCRETE ARCH BRIDGE WITH BAR AND STIRRUP REINFORCEMENT.

In continental Europe the use of small bars and of metal netting for reinforcing concrete arches is quite as common as is the use of what may be termed girder types of reinforcement like the Melan and Wunsch. The practice of the United States has been diametrically opposite. So seldom have small bars and metal mesh been used that a bridge so reinforced stands out prominently from its fellow concrete-steel arches. It is this circumstance that lends interest to the structure illustrated in the accompanying cuts,

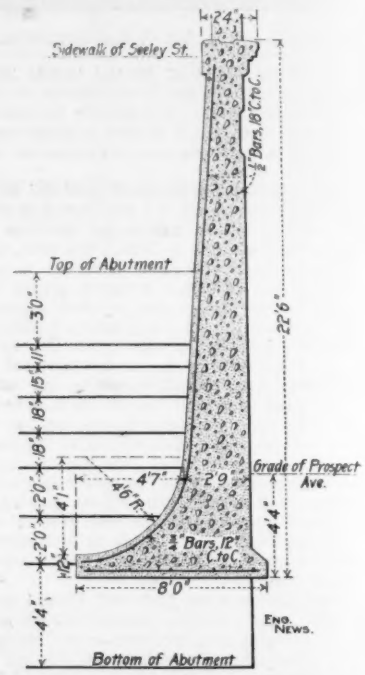

Fig. 3. Section (A-B) Through Wing Wall Showing Reinforcement.

FIG. 4. VIEW OF CENTER FOR ARCH RING.

FIG. 5. VIEW SHOWING ABUTMENT CONSTRUCTION.

notwithstanding that it is not remarkable either for its length of span or for the flatness of its arch ring. The bridge illustrated carries Seeley St. over Prospect Ave., in the Borough of Brooklyn, New York city, and is a skew structure with a span of 85 ft. 4 ins. and a rise of 8 ft. 0½ ins. The drawings of Fig. 1 show a transverse and a longitudinal section of the bridge.

In constructing the arch the first task after the excavation and the placing of the abutment footings, was to build the arch center shown by Fig. 4. At the ends of this center the vertical forms for the under arch faces of the abutments were erected. For the corbelled rear face no special form was used, the earth being simply stripped back and the concrete deposited against it. The

FIG. 6. GENERAL VIEW OF WORKING PLANT AND BRIDGE UNDER CONSTRUCTION.

The reinforcement of the bridge consists of corrugated steel bars. Tests of these bars showed an elastic limit of 66,630 lbs. per sq. in. and an ultimate strength of 106,270 lbs. per sq. in. for the large bars, and an elastic limit of 65,880 lbs. per sq. in. and an ultimate strength of 105,170 lbs. per sq. in. for the small bars. These bars are arranged in the form of an intradosal and an extradosal network of intersecting bars which are connected through the arch ring by vertical tie bars. The intradosal network consists of longitudinal bars 1¼ ins. square spaced 8 ins. apart transversely of the arch ring, and of transverse bars ½-in. square spaced 18 ins. apart longitudinally of the arch ring. The extradosal network is identical in construction and its component bars are located vertically above the corresponding bars in the intradosal network. The vertical tie bars are located at the intersections of the longitudinal and transverse bars, but they connect the upper and lower longitudinal bars only as indicated by Fig. 2. These tie bars are ¼-in. square and are attached by being hooked under the lower bars and hooked over the upper bars. In the intradosal netting the transverse bars are beneath the longitudinal bars and in the extradosal netting the transverse bars are above the longitudinal bars. The transverse and longitudinal bars in each netting are wired together at intersections at intervals only and only for the purpose of holding them in their proper relative positions during construction.

By referring to the illustration, Fig. 1, it will be seen that at the springing lines the intradosal netting bends downward and enters the abutment in a vertical plane. The extradosal netting, however, is discontinued at these points by the omission of the transverse bars, while the longitudinal bars are continued back into the abutments as anchor bars. The abutments themselves are of rather novel design, since they are corbelled out at the rear and top, and this corbel is reinforced to withstand cantilever action, as shown by the illustration. The abutment wing walls and the spandrel walls are continuous and are reinforced with corrugated bars, as shown by Fig. 3.

Portland cement concrete was employed for all parts of the bridge. For the abutments the mixture used was 1 part cement, 2½ parts sand and 5 parts 1½-in. broken limestone, and for the arch ring the mixture was 1 part cement, 2 parts sand and 4 parts 1½-in. broken trap rock.

placing of the front and rear face reinforcement of course preceded the deposition of the concrete. The view, Fig. 5, shows the abutment completed to about the level of the springing line and illustrates very clearly the position of the intradosal netting where it turns down into the abutment and also the position of the reinforcing bars for the corbelled rear face. The view, Fig. 5, also shows the beginning of the forms and reinforcement for the abutment wing walls. These were completed up to the cornice level before any concreting was done on the arch ring, as is shown by Fig. 6.

After the abutments had been brought up to about the level shown by Fig. 5, the arch ring reinforcement was placed. The intradosal netting was first laid and blocked up the proper distance from the center. The haunch bars of the extradosal netting were then placed and their abutment ends were concreted in as indicated by Fig. 7. Work on the upper netting then proceeded from haunches to crown, the longitudinal bars being carried by timber bents or horses standing on the center, as shown by Fig. 7. The tie bars had one end hooked over at the forge to engage the longitudinal bars of the lower netting and when about to be placed their top ends were heated so that they could be bent around the corresponding bars of the extradosal netting. This task was a very tedious and fussy one. Splices in the netting bars were made by lapping the ends and winding the lap with wire ties. In the longitudinal bars the splices came over the haunches and were made in every case to break joints. The transverse bars generally had two splices breaking joints. The views, Figs. 6 and 7, show the reinforcing members of the arch ring practically ready for the placing of the concrete.

The concreting was begun at the abutments and proceeded continuously from both ends toward the crown until completed. For night work the structure was lighted by electric lights located as shown by Fig. 6. Work began Saturday morning and continued 20 hours a day until the following Friday night. During this time some 600 cu. yds. of concrete were placed. The concrete used was mixed quite wet and the task of filling it around the bars was one which required care and watchfulness. Some difficulty was experienced because of the large size of the broken stone, 1½ ins., and the contractor states that should he have the work to do over and be given his choice of size for broken stone he would make the maximum size 1 in. The concrete was machine-mixed and was delivered to the tampers by wheelbarrows. The view, Fig. 6, shows the working plant quite clearly.

While the arch ring was being concreted the spandrel wall forms were being constructed, as shown by Fig. 6. These were of timber, and were provided with cornice molds, as shown. The face lagging was pine-dressed smooth and was covered with a greased building paper. Upon removing the lagging it was found that the paper had wrinkled from contact with the wet concrete, and these wrinkles of course showed in the concrete. To remove them it was found necessary to rub the concrete with brick and water and to apply a thin cement grout wash.

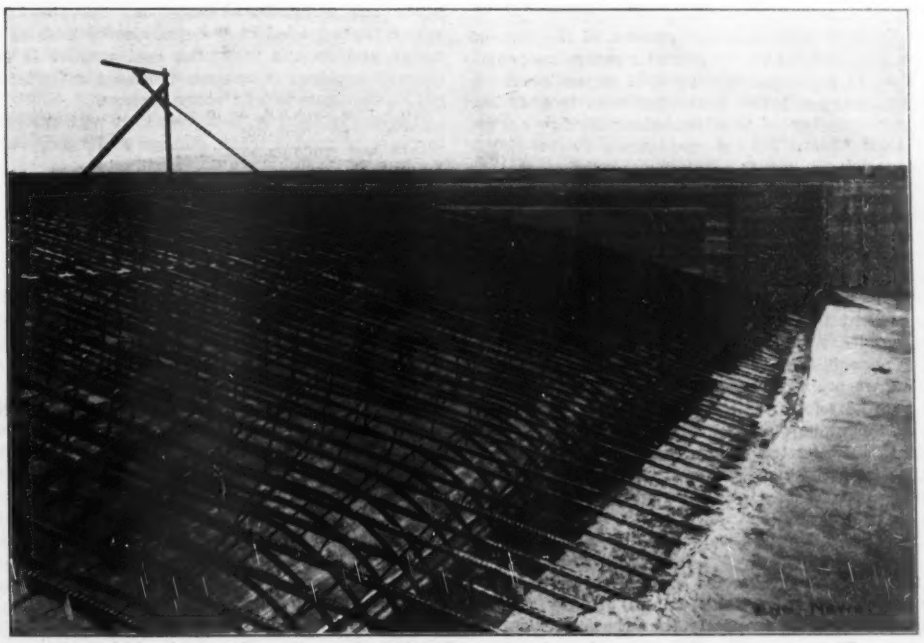

FIG. 7. VIEW SHOWING REINFORCEMENT AT HAUNCHES.

The construction of the bridge was begun on Sept. 11, and it will be completed about Jan. 1, 1904. There were 91,360 lbs. of steel and 1,300 cu. yds. of concrete required. The contractors are D. Cuozzo & Co., of 150 Nassau St., New York city, whose contract price for the work was $21,800. The bridge was designed by E. J. Fort, Assistant Engineer, Department of Highways, Borough of Brooklyn.

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If the new municipal government of the City of New York desires to carry out its campaign promises as to economy in municipal expenditures, it cannot make a better beginning than to abandon the construction of the Manhattan Bridge across the East River. As our readers are aware, Engineering News has from the outset opposed this bridge as an unnecessary expenditure of public funds. Some eighteen months ago, in our issue of May 22, 1902, we discussed this question in much detail and showed conclusively that with two more bridges and two tunnels actually under construction across the East River, another bridge close to the present Brooklyn Bridge was wholly unnecessary, at least for a long time to come.

On page 594 of this issue we reprint the map which we prepared to accompany our editorial of 18 months ago, and it furnishes quite as strong an argument now as it did then. This map shows that the Manhattan Bridge when built will draw traffic from the very same sections which are now accommodated by the old Brooklyn Bridge, and which will have the Rapid Transit tunnel lines in addition long before the Manhattan Bridge could be completed.

It must be remembered also that the new Williamsburg and Blackwell's Island bridges are of much greater traffic capacity than the old Brooklyn Bridge. Thus, to make the comparison in concrete form, the old Brooklyn Bridge carries two elevated railway tracks and two tracks for surface cars. The Williamsburg Bridge carries six tracks instead of four. The Blackwell's Island Bridge will carry six tracks. The Rapid Transit tunnel will have two tracks. The Pennsylvania tunnel will have four tracks. Thus, instead of the four tracks which have hitherto sufficed to carry passengers across the East River, ten tracks are already available, and with the completion of the lines now under construction there will be no less than 22 tracks to carry the traffic. Surely, before incurring enormous expenditure for still further additions it is the part of wisdom to wait and see whether there is need for it.

It will cost the city nothing to wait. The substructure for the Manhattan Bridge represents a dead investment till made use of, it is true; but on the other hand, the investment in the whole bridge will be a dead loss except as it carries a traffic proportionate to its capacity.

If it transpires five or ten or fifteen years hence, after all the bridges and tunnels now under construction are completed and in operation, that there is need for still further traffic facilities across the East River, the city can then raise the fifteen million dollars, more or less, necessary to place a superstructure on the completed foundations of the Manhattan Bridge, and to build the necessary approaches and terminals, and the work can be carried out in a very short time.

Of course, if the city had "money to burn," the Manhattan Bridge superstructure might be a good enough place in which to burn it now; but the city has not enough money for its needs, nor can it obtain it except by creating greater debt burdens and tax burdens than are justified. The city needs the additional water supply that has been so admirably planned. It needs also more schools, more lines of rapid transit, subways for pipes and wires, municipal buildings—all these and many other things it needs far more than it needs further multiplication of transit lines across the East River at enormous expense.

Therefore we say that the best way for the new administration to decide whether it shall build an eye-bar bridge or a wire cable bridge across the East River at the Manhattan Bridge site will be not to build any bridge at all.

The very serious wreck on the Baltimore & Ohio R. R. last week, due to a passenger train striking some heavy timbers which had been dropped from a freight train on the opposite track, is the most serious train accident resulting from this cause that we are able to recall. The real wonder is, not that accidents of this sort occur, but that they do not occur more frequently. When one considers the vast number of flat and gondola cars carrying loads of timbers, posts, structural steel, and other materials liable to displacement in transit, and when one remembers, moreover, the shocks to which these loaded cars are subjected both in the yards and on the road, the real wonder is that cases of accident from such displaced material are not more common and more serious.

It is probably true, however, that with the rapid increase of double track mileage and the growing volume of freight traffic, accidents due to one train fouling the opposite track are on the increase. It is noteworthy that only a couple of days before the Baltimore & Ohio disaster, a freight wreck occurred on the Lehigh Valley R. R. near Woodfern, N. J., due to the shifting of iron bridge trusses loaded on a flat car. The trusses were struck by a freight on the opposite track and the locomotive and ten cars were wrecked, the engineer and fireman narrowly escaping with their lives.

The prevention of such accidents lies with shippers even more than with the railways. It must be realized that the loading of freight cars with logs, lumber, steel and any other material liable to shift in transit, should be in charge of a man fit to trust with responsibilities involving the safety of human life. Of course the railway employees are charged with the responsibility of seeing that material is properly and safely loaded before accepting cars for shipment; but there is always a tendency to accept freight where the fastening is a little less secure than it should be rather than start a controversy which will cause delay in the shipment and perhaps offend an influential patron of the road.

In this connection it is certainly worth consideration whether for loading such material, particularly for shipment long distances over foreign roads, greater use should not be made of high-side gondola cars instead of flat cars. It is true that such cars are a little less convenient to load, but a saving is made in the cost of the stakes and other fastenings necessary to secure a load on a flat car, the cost of which, if the work is properly done, may be quite an amount.

We commented in our issue of Nov. 20 on the deficient power station equipment of a large proportion of the electric railway lines of Greater New York, and on the intimate relation between the shortage of current and the use of electric current for heating the cars. The "complaint columns" of the daily newspapers indicate that the situation is being solved by the railway managers through the simple expedient of leaving the heaters unused. In fact, the Brooklyn management is publicly quoted to the effect that as there is not enough current to be had to run the cars and heat them too, they have no choice but to turn off the heaters. This is perhaps a valid defence, but it is cold comfort for the public which has to ride in such cars in inclement winter weather; and it gives no hint as to whether it is ever intended to increase the power-station equipment to a degree sufficient to furnish current to really heat the cars in severe weather. Incidentally it would be of interest to know what power-station equipment would be required to furnish sufficient current to maintain a temperature of say 60° in zero weather in the cars of some of the large street railway systems. If this were known, one could form some idea as to whether the street railway managers really intend to heat their cars with electric heaters or only to use them to "take the chill off" to a moderate extent at such times as current can be spared.

Those of our readers who are familiar with the mathematical theory of probabilities are aware that the conjunction of two rare phenomena is vastly less frequent than the occurrence of either phenomenon singly. On this basis we feel fully justified in calling attention to a recent notable occurrence at Fargo, No. Dak., as reported in the "Call" of that city. In its issue of Dec. 19, that newspaper published a record of the proceedings of the Fargo City Council from which we quote as follows:

> **Mayor Sweet reported to the council that Acting City Engineer Atkinson felt that the work of his office during the winter months is so unimportant and not of sufficient quantity to demand the whole of his time, and therefore did not feel that he should accept the $100 per month salary, and had asked that it be cut to $50. The council did not look upon the matter very kindly, and Aldermen Schruth, Cummings and McKellar expressed themselves as believing that Mr. Atkinson's services as engineer were well worth what it costs the city and that as the salary is fixed by ordinance it was their opinion that it should not be changed.**

The spectacle of a municipal official presenting a formal petition to have his salary reduced one-half, on the ground that his services are not worth more, is rare enough to be worth record; but that a Board of Aldermen should reject such a petition on the ground that the services of the official (and that official an engineer) are worth all he receives—such a phenomenal conjunction deserves to be set down in history and marked by monuments.

A good idea of the troublous times through which the ship building industry is passing, abroad as well as in the United States, is furnished by a recent report from the U. S. Consul at Newcastle-on-Tyne, from which we quote as follows:

> **A well-known shipbuilding firm on the Wear has just contracted to build for a Liverpool firm of shipowners a steamer of 6,000 tons carrying capacity for the sum of £34,000 ($165,461), or a little over £5 10s. ($26.75) per ton. This is probably the lowest price that has ever been quoted or accepted for a properly equipped cargo steamer, and is but very little more than half what would have been asked for such a vessel two years ago. It shows clearly how shipping property has depreciated in value, and it also offers a convincing proof of the difficulty of obtaining orders and keeping machinery in operation. If the cost of material had not fallen to a very material extent it would have been impossible for even the most up-to-date shipbuilding concern to undertake work at the price mentioned, as the price of labor has not been lessened to any appreciable degree.**

It is uncertain whether the 6,000 tons really means "6,000 tons carrying capacity," as stated, or whether it means gross tonnage, by which vessels are commonly rated. The latter, however, seems the more probable assumption.

With such conditions at the great ship building and ship owning center of the world, similar conditions are bound to prevail, to a greater or less extent, in American shipyards, even if the indus-

try here had not been ruined by being placed in the control of a set of men who knew nothing about ship building, and, as the event has proved, less about finance.

The fact that vessels can now be purchased at half the price quoted two years ago is also of interest in connection with the purchases of English shipping by Americans, which aroused so much comment—wise and otherwise, about two years ago.

One of the greatest drawbacks to engineering progress in the United States is the failure to properly maintain and operate engineering works. Money is often spent without stint to erect works of a monumental character, under the direction of the best engineers in the country, and then after a flourish of trumpets these works are accepted by their owners and turned over to men without training or ability to handle them. This is particularly true of many classes of public works, and in no case is it more unfortunate than where public water supplies, and particularly water purification plants are involved.

Elsewhere in this issue may be found an abstract of an address on water filtration recently made by Mr. Allen Hazen, M. Am. Soc. C. E., in which he deals with faults of both design and operation of filter plans. In a portion of his remarks omitted in our abstract he called attention to the fact that the total cost of filtered water is divided about equally between capital charges and operating expenses, which fact was used to emphasize the need of more attention being paid by cities and water companies to the operation of their filters. Mr. Hazen urged that filter plants should always be under the control, if not the direct superintendence, of a chemist or bacteriologist. No better illustration of the need of such supervision of filters could be afforded than the experience which Butler, Pa., is now passing through. The water company stationed a bacteriologist at the filters after the typhoid epidemic was far advanced. Had this been done earlier there is good reason to believe that the epidemic never would have occurred.

SOME LESSONS OF THE BUTLER TYPHOID EPIDEMIC.

Hard as it is upon fever-stricken Butler, the typhoid epidemic in that community may be the means of saving thousands of lives elsewhere by directing public attention to the dangers of polluted water and inefficient sanitary administration.

We say thousands of lives advisedly and with full knowledge that the total number of deaths in such epidemics as that at Butler or at Ithaca fall far short of any such number. The fact is that the great mortality from typhoid fever results from the numerous cases which are occurring all the time in all parts of the country without the disease becoming sufficiently prevalent to be called epidemic.

In the past twenty years there have been only two typhoid epidemics comparable with that at Butler, viz.: Plymouth, Pa., in 1885, and Ithaca, N. Y., a few months ago. The total number of recorded typhoid cases in these three epidemics will probably be somewhere near 3,500 to 4,000, and the recorded deaths 300 or more. Meanwhile not a year has gone by when thousands upon thousands of persons have not been stricken and many thousands died on account of the pollution of the public water supplies of the United States. In other words, the great water-borne typhoid epidemics have been few and at long intervals, but there are numerous cities with polluted water supplies in which typhoid is always prevalent.

Thus it is not merely to avert the danger of epidemics that thousands of American communities need radically to reform their sanitary conditions. Such action is needed to eliminate the cases of typhoid which occur every year and often at all times of the year.

What at first thought may seem to be a sweeping condemnation of private ownership of waterworks is the fact that the three great typhoid epidemics at Butler, Ithaca and Plymouth were all caused by water supplied by private water companies. But on the other hand, what shall be said of the equally striking fact that municipal-owned water-works head the list of cities with continuously high typhoid mortality? For the years 1898 to 1901 the city of Pittsburg, most of whose population is supplied with water from city works, had an average typhoid mortality of 113 per 100,000, standing at the top of the list of cities of 30,000 and upwards. Charleston, S. C., under private ownership, came next (110), but was followed by three cities owning their works, namely: Youngstown, O., Allegheny, Pa., and Troy, N. Y. (109, 90 and 90, respectively). It would be interesting, and perhaps profitable, to go on through the list and see how the ownership stands as the typhoid mortality lowers, but our present space and purpose will not permit such an analysis. While there is reason to believe that a pure water supply can be more readily secured and maintained under municipal ownership, it is at the same time true that polluted water is now being furnished by hundreds of water-works, included in which are very many works owned by cities as well as those owned by private companies.

Even in cities where radical changes in the water-works are not needed, there is frequently urgent need for a thorough sanitary study of the water supply, to be followed by constant sanitary supervision, all under the direction of technically trained men.

To inaugurate such sanitary reforms there is needed not only action by the towns and cities but by state authorities. It is not difficult to trace a direct connection between the epidemic at Butler and the fact that Butler is located in the State of Pennsylvania. That state, to put matters plainly, is well known among sanitarians to be notably backward in all matters concerning the protection of the public health. This is not a mere matter of opinion. It can be shown by statistics which represent human lives.

In order to show by concrete example what sanitary neglect in Pennsylvania really means, let us compare the records of typhoid fever mortality in its cities with those of cities in Massachusetts, a state much more densely populated, but well known the world over for its advanced position in matters of sanitation.*

Among the cities of the United States having 30,000 population and over for which typhoid mortality statistics for the four years 1898 to 1901 are available, Pennsylvania has 15 and Massachusetts has 17 cities. Nearly all the Pennsylvania cities are among those of high mortality and every one of the Massachusetts cities is among those having low typhoid death rates. The total range of the table, it may be added, is from the very high rate of 113 to the low rate of 6 deaths per 100,000 of population per annum.

Pittsburg heads the table with 113 typhoid deaths per annum, and Allegheny comes fourth with 90. Johnstown stands sixth and York ninth, making four Pennsylvania cities among the first ten. The four Pennsylvania cities in the last half of the table stand No. 67, 75, 94 and 95, the last two being Erie and Scranton, each with an average typhoid mortality of 25 per 100,000.

Turning now to Massachusetts, we pass entirely over the first half (61 cities) of the list and on down to No. 76 before we find a Massachusetts city, and then find New Bedford, with an average mortality of 30 per 100,000. The next Massachusetts cities are Boston (No. 77) and Springfield (No. 92), the latter showing a typhoid mortality of 26. Thus, of the 17 Massachusetts cities with over 30,000 population, only three have a typhoid mortality rate above 26.

Looking on down the list among the cities of relatively low typhoid rates, we find that 11 of these 17 Massachusetts cities have a rate of 20 or less per 100,000, a rate lower than that of any Pennsylvania city in the table.

To what shall the vastly superior showing of the Massachusetts cities be ascribed? The records of the past show that it is due almost wholly to the relatively high character of the water supplies and to efficient sanitary administration.

Several years ago a number of Massachusetts cities were notorious for their high typhoid death rates; but the work of the state and local Boards of Health, backed by a sound public opinion, has largely remedied former evils and has made the state foremost the world over for its efficient sanitation. The work of the Massachusetts State Board of Health in lessening water pollution and solving the problems of sewage and water purification has been recognized by the sanitary experts of all civilized nations as one of the most notable advances in public sanitation ever recorded.

Contrast with this record the record of Pennsylvania. Among sanitarians, foreign and American, the state is chiefly notable as an example of the results of sanitary neglect.

For decades the great city of Philadelphia has had to drink the foul waters of the Schuylkill and Delaware, and thousands of lives have been thereby sacrificed. Only now, after a generation of agitation and delay, has the city entered upon the construction of filtration plants to purify its water supply.

Pittsburg, which, as we stated above, has long been notorious for its high typhoid rate and is now suffering to an extent which almost assumes the proportions of an epidemic, deserves credit for having a few years ago expended a large sum in water purification experiments. It deserves nothing but discredit, however, for ignoring these experiments and delaying the work of water purification. Its citizens suffer and die by the hundred, while rival politicians and contractors struggle for party advantage and personal gain, in connection with the proposed construction of filtration works.

Allegheny, so far as we can learn, also continues to pay a heavy penalty for impure water, notwithstanding the huge filter crib at its Allegheny River intake which it constructed at great expense a few years ago.

Reading, standing No. 33, or just below Philadelphia, in the list of cities already reviewed, is making some progress toward the introduction of filters, but its past record is not one to be proud of. At Chester the water company has installed filters, but it appears to have been driven to do it by litigation.

It would be interesting to inquire to what extent the backward sanitary condition of Pennsylvania is due to its local municipal government or to its state government. Undoubtedly both are deserving of extreme censure. The state legislature has not been liberal in its appropriations for the State Board of Health, nor has it clothed that body with the powers which it needs to carry on a fight against water pollution. Moreover, unless by quite recent legislation, needed powers for the conservation of the purity of public water supplies has not been granted to either local authorities or water companies. With such a record is it any wonder that Pennsylvania has to its debit two of the three great typhoid epidemics which have occurred in this country or that most of its large cities have for years reported heavy mortality from typhoid?

It may be said in defence of Pennsylvania, perhaps, that her sanitary condition is no worse than that of the states which have not been named and that a comparison with Massachusetts, noted the world over for its sanitary achievement and its excellent state and local government, is unfair. Even if such a plea could be supported by facts, which is doubtful, is it a worthy defence?

Pennsylvania as a state is wealthy and prosperous; it can afford to better its sanitary condition. The cities which have grown up within its borders entail a responsibility that may not be lightly ignored. Sanitary conditions inherited from primitive days become unbearable as population grows more dense and as means for the spread of communicable disease are multiplied.

It is, therefore, no defence for Pennsylvania to cite the backward sanitary condition of states farther east or farther west. The state is rich enough to afford good sanitation and its densely populated cities demand such sanitation as the

*For the purposes of this comparison we have availed ourselves of statistics compiled by Mr. Geo. W. Fuller, Assoc. M. Am. Soc. C. E., of Hering & Fuller, New York city. The statistics were compiled from tables published in the bulletins of the U. S. Department of Labor, and were presented by Mr. Fuller in a paper read by him before the Minnesota State Sanitary Association, Dec. 17, 1902. The full paper appeared in "The Municipal Journal and Engineer" for February, 1903. Although it now lacks two years of being up to date it will serve for general purposes of comparison.

price of their citizens' lives. It is to be hoped that such object lessons as the calamity at Butler may have an influence toward bringing about reform.

LETTERS TO THE EDITOR.

What Constitutes "An Acre of the Actual Area Cleared?"

Sir: Where a railroad specification states that "grubbing and clearing shall be paid for by the acre of the actual area cleared," I should like to have your opinion, or that of some of the readers of your valued paper, as to how close the timber would have to stand in order to be considered as requiring continuous clearing.

2. How much area should be allowed for an isolated tree?

3. Should any difference be made between a large isolated tree which is very difficult to remove, and a smaller one which could easily be taken out?

Very truly yours, J. T. Dodd.

St. Louis, Mo., Dec. 18, 1903.

[We shall be pleased to receive answers to these questions from our readers.—Ed.]

The Best Design for a Compression Member for Roof Truss Sway Bracing.

Sir: The following problem has caused some local discussion. Will you kindly publish same and solicit comment:

It is required to design a horizontal compression strut having an unsupported span of 22 ft. and satisfying the following conditions: The strut is to be suitable for sway bracing for ordinary roof trusses. Simplicity in manufacturing and minimum weight are important points. Direct compression equals 20,000 lbs. Strut to act as a beam in carrying its own weight. Allowable compression per sq. in. equals $18{,}000 - 80\frac{l}{r}, -\frac{l}{r}$ not to exceed 120, where l equals length of span in inches and r equals least radius of gyration in inches. Yours very truly,

John C. Sample,

375 Mohawk St., Chicago, Ill., Dec. 22, 1903.

Durability of Wrought-Iron Nails.

Sir: Enclosed is a card which is put in each keg of nails shipped by the Mt. Hope Iron Co. This is of interest in relation to the discussion of Steel vs. Wrought Iron that has been opened in your columns, and indicates that at least one manufacturer of nails realizes the importance of making the nails of iron instead of steel.

Yours truly, Macy S. Pope,

Inspector, Associated Factory Mutual Insurance Companies, 31 Milk St., Boston, Mass., Dec. 22, 1903.

(We reprint the card enclosed below:—Ed.)

To the Consumer of Nails and all Interested:

For 75 years past, the old-time Iron Cut Nail, fulfilled well all conditions and requirements. Now we go a step higher and improve the Quality by Refining the Iron. Thus making it perfectly reliable and all that is wanted of a nail.

When you buy our Refined Iron Cut Nail, you get "Durability," Strength and Holding Power, that has no superior, if equal.

Experience shows that Steel Nails being made by Acid Process corrode rapidly, and become worthless in a few years, especially on exterior work.

Our Refined Iron Cut Nails will continue the 75 year record, and meet all present and new demands.

MOUNT HOPE IRON CO., Somerset, Mass.

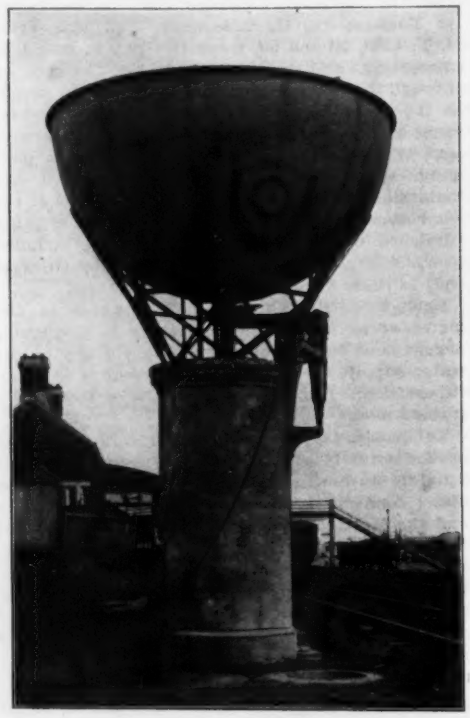
A Novel Type of Railway Water-Tower.

Sir: I send herewith photograph of a new standard design for combined tank and water crane for the Victorian Railways. The tank is 15 ft. in diameter and is constructed of ⅛-in. galvanized steel, riveted with 5-16-in. rivets of 1-in. pitch. It has a capacity of 5,000 gallons. The main T's are 3 × 3 × ⅜-in. and the diagonals are 2½ × 2½ × ⅜-in. angles. The tower is built with 9-in. brick walls laid in cement mortar and is 5 ft. 9 ins. in diameter. The top of the tank level is 22 ft. above the rail level. Yours truly.

A. Groudy.

Victorian Railways, Spencer St., Melbourne, Australia, Nov. 2. 1903.

(The photograph which our correspondent sends is of interest not only because of the peculiar design of water tank, but because of the overhead footbridge seen in the background, to enable passengers to reach the station without crossing the tracks. In the United States we have only made a beginning in the adoption of such safeguards on our lines of heaviest traffic, and very much more must be done before the long list of casualties at stations can be brought down to a reasonable figure. It is of course true that the public is as much to blame as the railway companies, and that it will require years to break up the long-established custom of using railway tracks as thoroughfares and of careless walking across tracks at stations. Nevertheless that work



The New Standard Type of Railway Water Tower, Victorian Railways, Australia.

of education must be done, and it can only be accomplished by furnishing over or under crossing of the tracks at stations and fences to prevent crossing at grade.

Turning now to the peculiar water-tower which is the chief feature of the photograph, it will doubtless occur to the reader that it would be hardly suited to a country of severe winter weather, since it would be difficult to protect from frost. Probably its chief advantage lies in the fact that it can be made of very thin metal, which is particularly important in Australia, where all iron and steel must be brought from the Antipodes.—Ed.)

Comments Suggested by Mr. Whinery's Articles on Street Pavements.

Sir: The articles by Mr. Whinery entitled "Some Observations on Street Pavements," in your issues of Oct. 22 29, and Nov. 5, especially the last, contain some assumptions regarding wheel loads as a basis for pavement design which would be far from applicable in this city. A wheel load of one ton per wheel is assumed, with a tire width of not less than 4½ ins.

The following load conditions have been observed and noted here during the past month. The observations were taken in reference to bridge repair and maintenance:

One company has 40 wagons hauling bulk material; one carries 13,000, three 12,500 and the others from 8,000 to 10,000 lbs. as an ordinary load. The heavier wagons weigh 5,000 lbs. each.

Wagons hauling another class of bulk material were stopped on the street and found to carry 12,300, 12,600, 13,200 and 15,000 lbs., respectively. These wagons weigh 3,000 lbs. each.

The manager of a large carting company says he has a class of wagons in constant use which, in hauling heavy freight, carry 20,000 lbs. as an ordinary load; one of the wagons is said to have carried 24,000 lbs. recently. The weight of these wagons is unknown, but is probably about 5,000 lbs.

The above are not exceptional cases, but rather representative in transportation of these three classes of material.

This loading gives a weight of 18,000 to 25,000 lbs. on four wheels, or a wheel load, if equally distributed, of 4,500 to 6,250 lbs. per wheel. It is probable that the load is not equally distributed between the front and rear axles. The center of gravity of many of the loads is high, and any lateral slope or unevenness in the surface of the pavement must produce a wheel loading in excess of the above.

In view of the foregoing, no wheel load of less than 6,000 lbs. could be assumed to fit the local conditions for ordinary heavy traffic. To this must be added the effect of impact, which may be considerable on an uneven pavement; and provision for unusual loads.

How far a city should go in building highways for unusual loads may be a point for argument, but the fact remains that such loads must at times be taken through the streets, and should be possible with the least inconvenience to all. Such weights moved on special supports or a large number of wheels or rollers, would be obstructions to ordinary traffic not warranted except in extreme cases.

During the present year loads have been hauled over our pavements weighing,with wagon, from 54,000 to 72,000 lbs. The former was moved on a warm summer day and did considerable damage to an old asphalt pavement, but little to a new asphalt pavement, and practically none to block stone. The latter and some intermediate loads were moved at a freezing temperature, and did practically no damage to asphalt or stone pavement. These pavements are laid on a 6-in. natural cement concrete foundation. The length of haul for these excessive loads was about three miles.

The width of the tire on the ordinary loads mentioned is from 4 to 4½ ins., and for the excessive loads 8 to 12 ins.

Mr. Whinery's argument for narrow pavements is especially applicable in the residence parts of this city. In a large portion of the city the houses are of the suburban style, with lawns at the sides and in front extending to the curb, with a 4 to 6-ft. sidewalk. An increase in the size of the lawn is an improvement of the property, and a decrease of the pavement a saving to the municipality in cleaning and maintenance. Most city vehicles can turn in little more than their length, and a width of pavement to allow one wagon to pass another backed up to the curb, with horses cramped to one side, should be sufficient for streets of light travel.

The diagram shown on page 405 of your issue of Nov. 5, having a turning place and a grass or flower plot in the middle of a block, would prove a serious obstruction to the passage of fire apparatus, and almost prohibitive for long fire ladder trucks.

A city wagon which cannot turn on an 18-ft. pavement should go around the block or to a wagon shop for repairs.

Respectfully yours, Geo. H. Norton,

Assistant Engineer, Department of Public Works.

Buffalo, N. Y., Dec. 1, 1903.

(The foregoing interesting letter having been submitted to Mr. Whinery, he submitted the suggestive reply thereto which is printed immediately below.—Ed.)

Sir: I thank you for the advance copy of the communication of Mr. Geo. H. Norton, Assistant Engineer, Department Public Works, Buffalo, N. Y., relating to statements in my papers on street paving, and for the opportunity offered me to comment thereon.

I was aware that such heavy loads as Mr. Norton mentions are occasionally hauled over streets, but I had no idea that they were as common as Mr. Norton's observations show them to be. With wheels of ordinary diameter a wheel load of 6,000 lbs. on the surface of an unyielding pavement means, according to my tests of area of contact, a pressure of not less than 2,250 lbs. per sq. in. Such a pressure approaches dangerously close to the strength of wood block pavement when saturated with water, and gives a very low factor of safety for the average paving brick. With a load of 7,000 lbs. per wheel, which would often occur on the rear wheels of a wagon carrying 24,000 lbs., concentrated upon an area not exceeding ½ sq. in., as it might often be on stone block pavement, the pressure would be dangerously near the crushing strength of Medina sandstone. The strength of asphalt pavement varies within wide limits with the condition of the pavement. When it contains no water and is slightly plastic, it will carry very heavy loads without serious injury, not only because it is then in a condition of maximum strength, but because the slight yielding under the wheel not only makes a perfect contact between the wheel and the pavement surface, but greatly increases the area of contact and distributes the pressure. Thus a yield under the wheel of 1-16-in. will increase the bearing area of a wheel 42 ins. in diameter with a tire width of 4½ ins. to 16 or 18 sq. ins., and thus reduce the unit pressure so that very heavy loads may be carried without material injury to the pavement. This is the main reason why the richer and softer pavements now generally laid are more durable than the harder and more unyielding pavements laid earlier.

Asphalt pavements are weakest and therefore most subject to crushing when they are saturated with water, and their temperature is so low that the material loses to a large degree its plasticity,—say from 32° to 45° F. That particular kind of disintegration of the surface called "scaling" or "pitting," nearly always occurs in the spring or autumn, during or just after a prolonged rainy spell and when the temperature is but little above freezing.

While therefore a good asphalt pavement will carry

very heavy loads without injury when dry and at a temperature at which it is slightly plastic, it may be very seriously injured under conditions which reduce its strength to a minimum; and the limit named in my article, 1,500 lbs. per sq. in., cannot be safely exceeded as a general rule.

It is evident, therefore, that loads such as those instanced by Mr. Norton must be very destructive to any kind of pavement, and should be prohibited. Even very wide tires should not excuse them since the load may be and often is concentrated on a very small area, regardless of the width of the tire. It would be very interesting if Mr. Norton would make experiments to determine the area of contact between pavement and wheels under these excessive loads. If he would place before the wheel a strip of paper two or three feet long, prepared as described in my article, and cause the wheel to roll over it, thus getting a print of the contact with the wheel in motion, the results would be very valuable in the further discussion of the matter.

Mr. Norton's approval of narrow roadways on streets of little travel is noted with pleasure. The sharp curve shown on my sketch, around the flower plot, would undoubtedly be awkward for fire trucks, but it is hardly necessary to say that if thought desirable the widening could be carried further in each direction so as to make the turn no worse than right angle turns on streets of usual width.

Very truly yours,

S. Whinery.

New York, Dec. 15, 1903.

Notes and Queries.

In the article on "The Practical Working of Trench Excavating Machinery" published in our issue of Dec. 24 an error occurred in the foot note on p. 563. The record of the machine as given in the second line from the bottom should have been 886 ft. in nine hours instead of 486 ft.

THE PROPOSED EXTENSION OF THE NORTH RIVER PIER HEAD LINE NEAR 23D ST., NEW YORK CITY.

The City of New York owns a large part of its extensive waterfront and leases it to various private shipping interests, either by leasing the pier space itself or by constructing suitable piers and pier-sheds and leasing these complete. Some years ago the city constructed a series of very large piers and pier-sheds, suitable for the largest trans-Atlantic steamers, on the east bank of the Hudson River (locally known as North River), extending for a quarter of a mile south of Gansevoort Street. These piers are leased and used as terminals by various trans-Atlantic steamer lines, such as the White Star, Wilson, and Leyland lines. Recently work has been begun on the construction of another set of similar large piers immediately to the north of this series, from 14th to 23rd Streets, in the Borough of Manhattan. These piers were designed to be 800 ft. long, and to secure this length inside of the pierhead line established by the War Department, a large area of land behind this location was acquired, cleared and excavated. The work of actual construction of the piers has not yet begun.

Over a year ago it was proposed to make these piers 1,000 ft. in length instead of 800 ft., to accommodate vessels of a greater length than any yet built. To secure the increased length without further extension landward, application was made to the War Department that the pierhead line at the location in question be moved 200 ft. out into the stream. This application met with refusal, as noted briefly in our issue of May 21, 1903, (p. 441). The application was repeated, however, reinforced with a report made by Mr. S. Whinery, M. Am. Soc. C. E., to the Commissioner of Docks of New York City. The application was referred to the New York Harbor Line Board of Engineer Officers which reported against the proposed extension, and Secretary of War Root therefore rejected the application. The docks are to be constructed, therefore, 800 ft. in length instead of 1,000 ft., and arrangements have already been concluded for their lease on completion to the International Mercantile Marine Co.

The reports of Mr. Whinery in favor of the proposed extension and of the Board of Engineers opposing it contain so much matter of general interest that we have deemed it worth while to print them in somewhat condensed form herewith.

To make the matter in controversy more easily understood by our readers unfamiliar with the local conditions, we reprint on page 594 a map of lower Manhattan, originally published in our issue of May 22, 1902, to illustrate the new means of communication across the East River by bridges and tunnels. It shows, however, the North River water front as well as is possible on such a scale and we have indicated by a dotted line the approximate position of the proposed extension, somewhat exaggerated as the scale made necessary.

The reports referred to we abstract as follows:

Report of Mr. S. Whinery.

Mr. McDougall Hawkes, Commissioner of Docks.
City of New York.

Dear Sir: The new pierhead line which you desire to have established is located along the western shore of Manhattan Island, beginning on the established pierhead line at the foot of West 30th St., and running thence southward, diverging westerly from the present pierhead line until it intersects the prolongation of West 23d St., at which point it would be 200 ft. outside of the existing line, thence running southward parallel to and 200 ft. west of the existing line to a point on the prolongation of Gansevoort St., from which point it approaches the existing pierhead line, which it intersects at a point on the prolongation of Canal St.

In this proposed extension there is involved a discussion of the following questions:

1. Will the proposed extension, if made, be detrimental to the navigation of the river or to its use as a harbor?
2. Are piers 1,000 ft. long demanded in the interests of the commerce of the port?
3. If piers 1,000 ft. long are necessary, is it practicable to secure them by extending the bulkhead line further inland?
4. Is this extension of the pierhead line on the Manhattan side of the river involve or justify an equal extension of the pierhead line on the opposite New Jersey shore?

A study of these questions, from a broad point of view, leads me to the following conclusions:

1. That piers not less than 1,000 feet long will be necessary in the very near future to accommodate the commerce of the port, and that provision should be made for them in the improvements now in progress.
2. The suggested project of securing piers of that length in the Chelsea improvement, by extending the docks still further inland, is open to so many various objections as to be impracticable.
3. The proposed extension of the Manhattan pierhead line does not involve or make necessary an equal extension on the New Jersey side of North River, nor does the commerce of the port require or justify such an extension on the west side of the river.
4. The extension of the pierhead line requested by you, will diminish the present width of the channel in that locality but slightly over seven per cent., and this slight reduction will not perceptibly interfere with navigation, or otherwise be appreciably detrimental to the harbor. On the contrary, the commerce of the port will, upon the whole, be benefited thereby.

The facts and reasons that have led me to these conclusions will be stated as briefly as practicable.

THE NECESSITY FOR PIERS 1,000 FEET LONG.

After the signal failure of the steamship Great Eastern, some forty years since, it was confidently predicted that ships of her size would not be again attempted, and the opinion was general that the practicable maximum length of ocean-going vessels would be found much short of that of the Great Eastern. This opinion prevailed for a considerable period of years, but gradually changed, and the tendency to increase the length of vessels has been very marked within the last decade. There are now in successful use no less than four vessels exceeding the Great Eastern in length. There is no evidence that the limit of length, whether considered from a structural or a commercial standpoint, has yet been reached; on the contrary, there is every reason to believe that vessels much exceeding in length any now in existence will be constructed and used in the not very distant future. The Cunard line is now arranging to build two new vessels, the exact dimensions of which are not, I believe, determined, but I am informed by an official of that company that their lengths will approximate 800 feet. If the present tendency to increase the length of vessels continues, as may be confidently anticipated, we may expect that ocean-going steamsips 900 feet long will be in use within the next dozen years, and that by 1928, vessels 1,000 feet long will be entering the port of New York. The marked improvements in steam boilers, the increased efficiency and decreased relative weight of marine engines, the concentration of the machinery into a smaller space, together with a material decrease in relative dead weight as the size of the vessels increase, all tend to encourage the building of larger and larger ships.

With the extension of the pierhead line you ask for granted, the way would be clear to provide, as soon as they may be needed, piers suitable for the accommodation of vessels at least 925 ft. long. To accommodate vessels of this length, slips about 1,000 ft. long are, as is well known, required.

Private shipping interests recognize the necessity of providing piers for present and future business, much longer than those now contemplated by your Department. The fact that the North German Lloyd Line is now building piers over 900 ft. long in Hoboken; that the Bush Company, Limited, is building piers 1,314 ft. long at South Brooklyn, and that the Pennsylvania R. R. has planned, and is engaged in constructing a great freight yard out from the Jersey shore at Greenville, to be provided with several piers over 3,000 ft. long, offers the strongest evidence of the growing necessity for piers of much greater length than has been thought necessary heretofore, in order to accommodate and foster the commerce of the port.

EXTENDING THE DOCKS FURTHER INLAND.

It is suggested that docks 1,000 ft. long may be provided inside the present pierhead line by extending the slips 200 ft. further inland than your present plans contemplate. This is open to so many weighty objections as to be, in my opinion, impracticable.

The great additional expense it would involve must be considered, though I regard this as of less importance than the other objections that will be referred to later. To advance the bulkhead 200 ft. landward along the Chelsea improvement would make it necessary to acquire something over 400,000 sq. ft. of private property and to vacate about one-half mile of existing streets. I have not at hand the information needed to make an approximately reliable estimate of the probable cost of securing this property, but from the best information at hand, I conclude that a conservative estimate of the cost of procuring this private property when you would want it, would be six millions of dollars. To this must be added the cost of clearing the ground, the cost of vacating or amending the street railroad franchise upon the streets vacated, and finally the cost of the construction of the additional works. I think you would be fortunate if the total cost did not exceed ten millions of dollars.

Whatever the additional cost might be, and however able the city might be to incur it, the burden would eventually fall upon the steamship lines in the way of increased dock charges. The steamship companies claim that New York is now the most expensive port they enter, and predictions are freely made that any increase of the burden may compel them to seek better accommodations and less onerous charges in other ports. Whether any importance be attached to these predictions or not, the great importance to the commerce of the port of keeping the taxes upon shipping as low as possible, is so well recognized that I need not enlarge upon the matter.

Lower Manhattan is rapidly becoming one of the most congested city areas in the civilized world, and the geographical features of Manhattan Island point inevitably to the conclusion that in the near future the area available for business and residence purposes is going to be totally inadequate. The city cannot spare and should not permit the appropriation of 400,000 additional sq. ft. of business area and more than one-half mile of streets for the enlargement of its harbor facilities. The construction of the greatest railway terminal in the world at 32d St. and Seventh Ave. will undoubtedly increase the business importance and value of property in the territory southward, and the enlarged and improved dock facilities in progress and in contemplation along the North River in the immediate vicinity of these purposed docks will greatly concentrate commercial business, already greatly congested, in that vicinity, and will render necessary all the room that can possibly be provided. It would be a very unwise policy on the part of the city to decrease the area now available for business purposes. It would be better from a commercial and economic view to enlarge her area by utilizing a part of the submerged ground wherever this can be done without serious detriment to navigation.

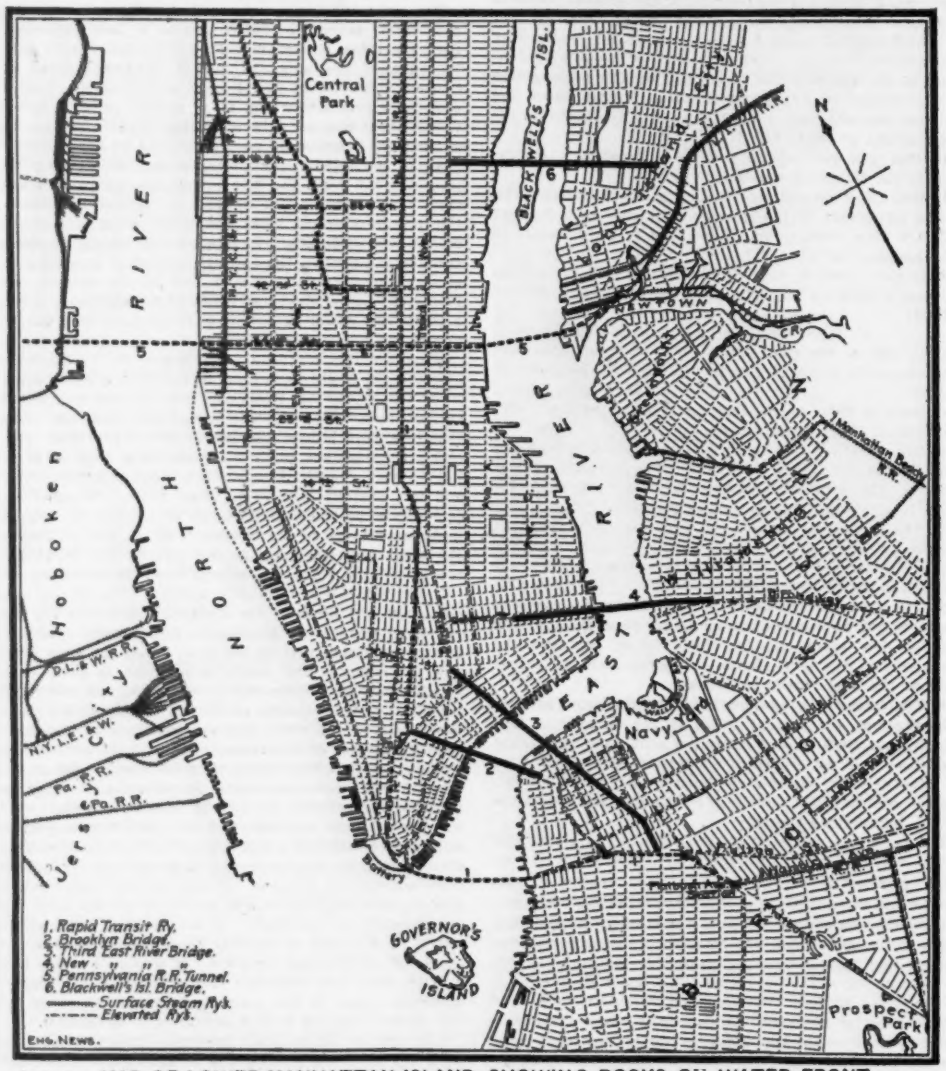
The effect of the proposed extension inward of the bulkhead line upon the present and future transportation system of the city, while it has been referred to, does not seem to have been given the attention its importance demands. Manhattan is rapidly approaching a crisis in street transportation matters, and if the city is to continue its present rate of growth, pressing questions of street congestion cannot much longer be neglected. Already this congestion has become so great that passenger communication between different parts of the city, and the distribution of freight, is very seriously impeded and delayed. One of the most difficult problems at the present time, and one that will continue to become more serious and pressing as the business of the city grows, is the movement and distribution of freight from point to point, and particularly between the terminii of the various ocean transportation lines and the business houses. At present this is done entirely by trucking. Freight arriving at the several piers is thus distributed to all parts of the city, and the consequence is that the streets are gorged with vehicular travel.

Many of those who have given careful attention to this subject believe that the most satisfactory solution of the problem will be found in the construction of an elevated railroad, having four or more tracks, around the entire waterfront of lower Manhattan. Such a road would connect with the piers along the North and East Rivers and would handle freight between them and stations nearest to the business houses from or to which it may be consigned. Whether this particular project shall be carried out or not, some such general plan for handling local freight along the water front of the city must be devised in the future, and should be borne in mind. The extension of the bulkhead lines 200 ft. further landward than proposed by the present plans of your department would

constitute a very serious obstacle in the way of carrying out any such project.

POSSIBLE DETRIMENT TO NAVIGATION AND COMMERCE IN THE HARBOR.

You state that the Chief of Engineers expresses the opinion that the pierhead lines on both shores at this locality have been placed as far out into the navigable waters as it is safe and wise for the interests of the harbor to place them; and that if further encroachments are permitted to be made, it will be only at the sacrifice of a portion of the present harbor and channel capacity, and at the expense of public commercial interests connected therewith, but you do not, however, give the reasons that led him to this conclusion. If such a conclusion be supported by facts sufficient to establish it beyond reasonable question, his opinion should be final. But in the absence of the data and the arguments upon which his opinion was based, I am left to investigate the subject independently.



MAP OF LOWER MANHATTAN ISLAND, SHOWING DOCKS ON WATER FRONT.
(Reproduced from Engineering News of May 22, 1902.)

The minimum distance between pierhead lines as now established, scaled from the official map before me, appears to be 2,800 ft. If the pierhead line should be advanced on the Manhattan side 200 ft., the clear space remaining would be 2,600 ft., and the channel width would be reduced slightly over 7%. It is difficult to conceive how such a slight reduction could seriously impair the usefulness and safety of the harbor, or obstruct navigation, unless it may be shown that the available space is already so contracted as to afford insufficient facilities for the requirements of navigation and commerce. It is not claimed by any one, so far as I know, that such is the case. It is unnecessary here to more than call attention to the fact that the harbor of New York is one of the most commodious of the world, and that even if the commerce of the port should increase many fold, its capacity would still be ample, as compared with the capacity of a great majority of the busier harbors of the world.

Restricted space in a harbor may be objectionable for two reasons: First, there may not be room for safely and expeditiously berthing arriving vessels in their slips, or for getting them out to sea from their slips. This at once raises the question of the space required for manoeuvring vessels in entering or in leaving their docks. This space, other things being equal, obviously increases with the length of the vessels. But in this connection it must be borne in mind that all or nearly all of the great modern ships are equipped with twin screw propellors. The introduction of the twin screw marks an epoch in the navigation and control of ships. The use of two propellors, one of which can be reversed while the other goes ahead, placed in the hands of the navigator a new and powerful auxiliary to the rudder, enabling him to change the course of his vessel, or to turn it around, within limits of space and time that was before impossible. It is the boast of the captains of the great modern twin-screw ships that these vessels can be turned in a circle whose radius exceeds but little, if any, the length of the vessel. It is this power of control that has practically revolutionized the handling of the great modern ships, enabling them not only to navigate crowded harbors with comparative safety, but to reach and enter their slips within limits of space and time that seem marvelous. This fact must be given its appropriate weight in considering the harbor room required for handling modern vessels.

The absence of any considerable current in the North River is a fact greatly favoring the handling of vessels, and makes less room necessary for their safe manoeuvering. The current at the locality in question never exceeds 1.3 miles per hour, and currents of even this low velocity are rare. The river may therefore be regarded as practically without current so far as affecting navigation is concerned.

Notwithstanding the narrowness, in some places, of the East River, the pierhead line on the Manhattan side below Corlears Hook was revised in 1890 by advancing it about 150 ft. further out into the river. The pierhead line at some points on the Brooklyn shore in the same locality, has also been modified and advanced more recently. The clear distance between established pierhead lines, at a point about 600 ft. below the Brooklyn Bridge, scales on the map about 1,300 ft., while a short distance above the bridge the clear width is about 1,200 ft. This channel is used by an enormous quantity of shipping, including war vessels, going to and from the Navy Yard. The distance between pierhead lines above the Navy Yard for a distance of half a mile does not exceed 1,600 ft. These narrow channels are made more difficult and dangerous to navigate by the strong currents, which sometimes reach a velocity of over 6 miles per hour, and by their curvature. These narrow channels are obviously inadequate for the enormous quantity of shipping that passes through them, and the advancement of the pierhead lines was doubtless authorized only because the interests of commerce demanded greater dock capacity. The fact of such advancement affords a good illustration of the principle I have referred to, that the available waterway in a harbor must be divided between docks and channels in such a ratio that the interests of commerce will, upon the whole, be best served.

While the conditions that prevail in harbors abroad are so different from ours as to make comparisons of little value, it may be worth noting that the river Mersey, whose single channel carries all the shipping, and forms the harbor of Liverpool, one of the most important ports of Europe, has a minimum width of 2,700 ft.

If, however, the Secretary of War shall, after full consideration, be of the opinion that it is unwise to reduce the present width of the channel, I would respectfully suggest that the full width of 2,800 ft. may be provided for and maintained while at the same time the extension of the pierhead line on the Manhattan side may be authorized. This may be accomplished by revising the pierhead line along the opposite New Jersey shore. This suggested revision would begin in the existing pierhead line on the New Jersey side of the river at a point opposite the foot of Sixth St., Hoboken, and would run hence northward, parallel to and 2,800 ft. from the new pierhead line on the Manhattan side, for a distance of 3,000 ft., and thence in a straight line to a point in the present pierhead line, at an angle in the same, about 300 ft. above the long pier of the N. Y., L. E. & W. R. R. A part of this revised line would lie in front of Castle Point, where long piers are not practicable, and above Castle Point the topography will permit of the construction of piers and slips as long as may be required inside the new line. Such a revision would not, if I am correctly informed, affect any important existing structures or interests.

Yours very respectfully,

S. Whinery.

New York, October 3, 1903.

Report of the New York Harbor Line Board.

Brig.-Gen. G. L. Gillespie, Chief of Engineers,
Washington, D. C.

General:

1. The New York Harbor Line Board has the honor to submit the following remarks upon the technical report of Mr. Samuel Whinery, C.E., dated Oct. 3, 1903, upon the proposed extension of the pierhead line in the Hudson River along what is known as the Chelsea Improvement.

2. The Board has given careful consideration to Mr. Whinery's report, which is directed principally to a discussion of the following questions: [See report above for questions.—Ed.]

3. The Board answers the four questions above:

First. The extension will, in the opinion of the Board, not only injure the harbor, but the tidal estuary of the Hudson River as navigable waters.

Second. Piers of 1,000 ft. or more in length may be required and may be constructed in great development within the harbor of New York.

Third. The Board has visited and inspected this locality, and believes that 1,000-ft. piers may be constructed at this point, if desirable, by dredging or otherwise excavating inland. Whether such process would be pecuniarily desirable for the City of New York, the Board has not the data upon which to form an opinion. The vicinity is not closely built up, is largely land reclaimed from the river, and the pierhead line as it now stands is more than 1,200 ft. in advance of this original shore line.

Fourth. The board is unable to say how the State of New Jersey may regard this question, but inasmuch as Mr. Whinery proposes in his paper that the established harbor line might be drawn back 200 ft. on the New Jersey side in order to admit of a corresponding extension on the New York side, the Board would remark that whenever the State of New Jersey and riparian owners under its laws, accede to such drawing back without cost to the public, it will be willing to recommend an equal extension on the New York side. The Board believes that the river is now narrowed to the extreme limit admissible in this vicinity.

It would appear, however, that the New Jersey authorities consider their State to be as fully entitled to an extension of harbor lines as New York, inasmuch as an application for an advancement of harbor lines along the New Jersey shore in this vicinity has been recently considered and reported upon adversely by this Board, and for the same reasons as in the case now under consideration.

4. It is stated in Mr. Whinery's report, that it is not understood to be simply a question whether the improvement is practicable, or whether it is justifiable or desirable from an engineering point of view, but as well whether the local interests require that it should be carried out.

5. This is a view of the subject that the Board cannot take. The commerce of the Port of New York is in large measure the commerce of other parts of the country, and is not merely that which affects the local interests, which would be provided for by piers in the specified locality. It is stated that piers 1,000 ft. long will be necessary in the very near future, 1928 being the date fixed when vessels of 1,000 ft. might be expected in the port,

though the longest vessels now contemplated will approximate 800 ft. in length. Mr. Whinery states that for vessels 925 ft. long, slips about 1,000 ft. long are required. If this be true, then slips of 1,000 ft. length will not be sufficient for vessels of 1,000 ft., and if, as stated by him, vessels of still greater length than 1,000 ft. may become practicable and commercially successful, a still greater length of slip will be required. Where then will be the limit of demands for contraction of channel if increased length of slips is to be obtained by advancing harbor lines?

6. If it were true that there is no other place within the limits of the port where long ships could be provided, and if the absence of such slips would be detrimental to the commercial interests of the country, the argument for the desired extension would have more weight, but the whole stretch of river on both sides from Spuyten Duyvil to the Battery, a distance of 13½ miles, there is no other locality where the advancemnt of harbor lines would be so detrimental to the navigation of the river as in the immediate vicinity of the proposed piers, where the river is at its least width.

7. There are long stretches of water front where piers of 1,000 ft. in length may be constructed, and Mr. Whinery states instances where within the limits of the Port and Harbor of New York, piers of lengths up to 2,000 ft., or more are now under construction. Along the Long Island and New Jersey fronts of the rivers and harbors and along the Jersey Flats and Newark Bay are vast extents of water front where, without advancement of harbor lines, long piers may now be built, accessible to the rail and water routes over which distribution must be made, and along Manhattan Island are stretches of water front where piers 1,000 ft. in length could be constructed by advancing harbor lines with far less serious contraction of channel width than in the vicinity of the proposed improvement.

8. The Port of New York, extending from Sandy Hook, N. J., and Coney Island Point, N. Y., to Throg's Neck on the East River, and to the City of Yonkers on the Hudson River, has a water front, excluding Harlem River, of approximately 187 miles. The water front of Manhattan Island, exclusive of Harlem River, is about 23 miles, or about one-eighth of the total water front. Along the entire front of North River there is no more objectionable point than that now in question for the construction of long piers. The East River front is crowded with piers for craft less than 500 ft. in length. This river has proved too narrow for berthing larger vessels, although the proportion of length of vessels to width of channel, favored by Mr. Whinery, should permit longer vessels to use East River.

9. In order that some idea may be formed of the congestion along the water front of Manhattan Island, it may here be stated that the cargoes of all vessels must be carried to and from the vessels by trucks. The lower streets of the city are now nearly impassable, due to the enormous number of these trucks constantly hauling parts of cargoes. Vessels of 20,000 tons capacity or greater are now under construction, and it is argued by Mr. Whinery that still larger vessels wil seek dockage here. The trucks will not average over two tons, so that 10,000 trucks or more may be expected to visit the pier when loading, and a similar number in discharging a full cargo from a vessel and there are many vessels along this front taking or discharging cargoes simultaneously.

10. It is not known to the Board what proportion of the cargoes of vessels entering and leaving the Port of New York and docking along Manhattan Island originates upon Manhattan Island, or what part of cargoes arriving lodges there finally. All parts of these cargoes originating outside of Manhattan Island, or distributed throughout the United States from this island, must now be hauled again and again through the streets of New York, and much of it carried across a river also, and the argument now submitted by Mr. Whinery is that this tax should be continued, and even increased, at the expense and inconvenience of the public.

11. If this freight or articles of commerce, be distributed by rail it must be by means of two systems entering Manhattan Island, seven with termini in New Jersey, and one with terminus on Long Island. The hauling of these articles of commerce on Manhattan Island back and forth through crowded streets, and the ferrying of much of it to and fro across rivers, when it might be avoided by better location of docks, is not in the interest either of the Port of New York in comparison with other ports of entry in the United States not so handicapped, or of the people of the United States who must ultimately pay the cost of such expensive hauling of goods out of place. It is not to the advantage of the people of the United States to have their commerce pay undue tolls at this port, nor it is to the advantage of the port to compel commerce destined elsewhere to be handled and rehandled on Manhattan Island.

12. If commerce is deserting the Port of New York, it is simply because it is to the benefit of the country at large to transact its business along lines of less resistance. This harbor or port must furnish facilities for commerce along the most economical lines.

13. Considerable space in Mr. Whinery's report is taken up with a description of this congestion of business now existing in New York at the locality in question, and it is stated that the enlarged and improved dock facilities in progress and in contemplation will greatly concentrate commercial business already greatly congested in that vicinity. In view of this it would seem unfortunate that the city had determined upon this particular locality, and had inaugurated extensive and costly improvements at a point where such great congestion already exists and must be materially increased thereby, and especially to select for its longest piers that part of the river where their construction would be most objectionable.

14. It is stated by Mr. Whinery that

> The absense of any considerable current in the North River is a fact greatly favoring the handling of vessels, and makes less room necessary for their safe maneuvering. The current at the locality in question never exceeds 1.3 miles per hour, and currents of even this low velocity are rare. The river may therefore be regarded as practically without current so far as affecting navigation is concerned.

15. Mr. Whinery does not give his authority for these statements, and it is evident that he has been misinformed. Measurements recently made at this narrow section of the river developed a velocity of 4.04 ft. per second, or 2.75 miles per hour, more than double the velocity stated, and as there was no considerable freshet in the river at the time, nor maximum oscillation of tide levels, it may be assumed that there are times when the velocity of current may reach or exceed three miles per hour, which is a velocity that would materially affect the handling of tows and single vessels of large size.

16. The Board fully recognizes the desirability and necessity of providing the best possible facilities for the handling of ocean commerce carried in the largest vessels that are or may be constructed, but as advisers to the guardian of the interests of the general navigation of the river and harbor, in so far as relates to the proper limitations to be placed upon the encroachments upon navigable channels, it cannot assent to any arrangement by which vessels are to be accommodated by further contraction of the most restricted part of the North River.

17. The Port of New York is not limited to the State or City of New York. It must be remembered that the State of New Jersey has an extended water front along the navigable waters of New York harbor, and it is to the interest of the commerce of the United States that use of this water front shall be made. The general public of the United States is very much interested in the question whether the advantages of this harbor—in great measure increased and made available by expenditures from funds in large part contributed by such public,—are properly and economically used for the general benefit. It is a matter of indifference to the people at large, whether their harbors are in the State of New York, New Jersey, Virginia, Louisiana, or elsewhere within the National domain, provided that the most economical lines of traffic, so far as affects their resources and business, are followed. An argument, therefore, based upon the advantages to accrue to a particular city or state has and should have no force, unless at the same time it is shown that the general public will be the gainer, or at least not a loser, by the execution of the proposed project.

18. In this connection the Board desires to particularly invite attention to the fact that the public now holds the right of free navigation over the waters of the United States outside of established harbor lines, but whenever a harbor line is advanced into the water, the United States relinquishes for the public the right of free navigation over the area shoreward of the legally established lines. Should any waterway be unduly contracted by such advance of harbor lines, the United States cannot correct such mistakes by cancelling a gift to corporations or individuals, but should it then be required to recover any part of this area, it must be done by purchase or condemnation of vested property rights. Harbor lines should therefore not be extended or advanced into public navigable waters unless it be clear that the general public loses nothing therby.

19. The Port of New York is renowned for its spaciousness, its safety, the magnificent development of its water front, and the convergence of many channels for foreign and domestic commerce. It is to these that the city owes its commercial supremacy, and any lessening of any of these advantages will tend to a deterioration of the port.

20. In arguing that the width of the North or Hudson River at the gorge is sufficient for much larger vessels than now dock in that vicinity, Mr. Whinery states, in effect, that the Hudson or North River may be regarded as nearly stagnant, and that twin-screw vessels practically turn on a pivot, or within their own length. The argument is based upon assertions that are not in accord with actual current measurements, as hereinbefore shown, or with everyday attainments in practice. Four times a day there is practically no current for a few minutes, then it increases to a maximum several times greater than Mr. Whinery states, and after passing the maximum decreases to zero. To any one familiar with the actual maneuvering of vessels of large size, with twin screws, the turning practically on a pivot, or within the length of the vessel, compared with the actual performances, is extremely interesting as a possibility, but the observations of members of this Board on large vessels attempting to dock along the Hudson River do not lead them to think that the operation is so simple, speedy and limited in area, as argued by Mr. Whinery. Large vessels with or without the aid of tugs attempting to dock at other than slack water are frequently prevented by the current from making their docks and often make more than one attempt. For some time they are broadside to the current and are serious obstructions to navigation while in such positions. Two 1,000-ft. vessels with absolutely necessary "elbow room" attempting to dock at the same time, on opposite or even on the same side of the river, near the gorge, would seriously obstruct navigation. The following clipping from the New York "Times" of Nov. 29, 1903, illustrates these remarks:

LINER CRASHES INTO A PIER.

Captain of the Incoming "Philadelphia" Miscalculates the Force of the Tide.

When the big steamship "Philadelphia" of the American Line came up to her pier yesterday on her arrival from Southampton, she poked her bowsprit through the second story of the pier at the river end, doing considerable damage to the pier and to herself. A crowd of more than 100 people, who had gathered at that end of the pier to watch the ship as she was warped in, had a narrow escape from being struck by the falling glass and splintered wood.

Tse vessel left Quarantine at 8 o'clock, and arrived off the end of her pier an hour later, but was compelled to remain in midstream until the "St. Paul" of the same line sailed, and vacated a berth. A strong ebb tide was running and Captain Mills, of the "Philadelphia," carried his vessel up stream a distance, and then allowed her to drift back. When the "St. Paul" had sailed, the "Philadelphia" was swung about, and headed for the pier.

Her captain miscalculated the distance which the tide would carry him down stream, and instend of the ship sliding into her berth, she struck the pier, head on. Her bowsprit crashed through the wooden structure, and was wedged in so tightly that it held for several minutes, while the tide swung the stern of the vessel down stream. A large hole was ripped in the building. The bobstay of the "Philadelphia" was carried away along with about 6 ft. of the bowspilt.

21. Aside from this, it may be seen by examining any authentic hydrographic map of this locality, that the engorgement of the river has produced markedly increased velocities of currents at this point, shown in effect by the gouging out or deepening of the river bed in this vicinity.

22. A further engorgement here, by extending piers or otherwise will result first, in an increase of hydraulic head and consequently velocity and attendant diminution of the volume of the tidal flow into and from the Hudson estuary, a fill at the head of and on bars throughout this estuary, and afterward and finally a deeper channel near the gorge.

23. Mr. Whinery argues that inasmuch as the Mersey at Liverpool is 2,700 ft. wide, a width of 2,600 ft. at the point in question is sufficient.

24. The Mersey is not a thoroughfare, in the sense that a large commerce passes Liverpool to other ports; but the North River is the outlet of the Erie and Champlain canals, bearing articles in part destined to coastwise and to foreign ports, and has a large local commerce; a total commerce much exceeding that of Liverpool in tonnage.

25. At Liverpool there are no slips or docks of the class known in New York Harbor, but there are extensive basins closed by tide or dock gates, similar to canal gates, entered and cleared from only at stages approximating high-tide level.

26. All of these basins or docks at Liverpool are on one side of the river, except the Birkenhead Docks, which are situated along a short tidal inlet on the opposite side of the Mersey, reached by one single and one triple entrance from the Mersey. This inlet may be compared to Newtown or Gowanus creeks, in New York Harbor, except that it does not compare with them in tonnage. At the one place where the width of the Mersey is only 2,700 ft., there are no docks for very large ships. The docks where very large ships may be berthed are situated where the Mersey exceeds 3,000 ft. in width, reaching 4,000 ft.

27. None of the Liverpool docks extend into the channel, or reach beyond the low water line, or in any way contract the estuary.

28. The entire water-borne tonnage of the Port of Liverpool, where the channels have been so carefully guarded, is only a fraction of that of New York. In all there are to be only 19 entrances to docks at Liverpool, counting double or triple entrances at any one place, twice or thrice or as two or three entrances; and the boats enter and leave them at stages approximating slack water. There seems, then, no basis of comparison between the Ports of Liverpool and New York, but any comparison relating to the matter of encroachment upon navigable channels in the Mersey and in the rivers and kills in New York Harbor, may result unfavorably to New York Harbor. Mr. Whinery does not anywhere in his paper note the effect of long vessels broadside to the current in obstructing the movements of other vessels using the thoroughfare.

29. The Board also observes that, in its opinion, there is nowhere shown in Mr. Whinery's paper any necessity for an advancement into the channel of North River of the harbor lines at this point. Nearly all the facts stated by him are against long piers in this vicinity, even if the river were not already too contracted there.

30. He shows:

(a) That long piers are now constructed and maintained much more economically in this immediate vicinity, on the opposite shore of the North River, in New Jersey, and at other points in New York Harbor.

(b) That all freight constituting cargoes of vessels landing along Manhattan Island is carried and distributed by trucks,and that the streets of New York are now too much

congested, and must be still more so, should these piers be built, unless costly methods not now provided for be installed for handling it.

(c) That the steamship lines directly, and their patrons indirectly, must pay for the increased cost of piers along Manhattan Island, or, in other words, that the commerce of the port handled at such piers must be more heavily taxed than if handled elsewhere in the harbor.

(d) That on account of heavy port charges and lack of economical facilities in New York Harbor, commerce is seeking other ports.

31. Mr. Whinery does not show that the construction of long piers in this vicinity, will result in less taxing of commerce, but he argues that it is now expedient (and advantageous for the Borough of Manhattan) to build long piers in connection with an important improvement now in progress in this vicinity, and that the conditions are now favorable for costructing such piers.

32. Under his showing it is simply a matter of convenience and expediency in the interests of the Borough of Manhattan; but he does not show that such extension would be in the interest of the general public or even of the Port of New York.

33. In conclusion, the New York Harbor Line Board has to report that after maturely considering the arguments of Mr. Whinery and all the bearing of the case, it is confirmed in the opinion, heretofore expressed, that it is not to the interest of the public that the harbor lines be advanced in this vicinity, but that on the contrary, such an extension as is requested would be against the public interests, inasmuch as it would diminish the navigable capacity of North River and be obstructive to navigation, while at the same time offering no compensating advantages to the public at large.

36. The Board, therefore, respectfully recommends that the application be denied.

Respectfully submitted: Chas. R. Sutter, Colonel, Corps of Engineers; Amos Stickney, Colonel, Corps of Engineers; W. L. Marshall, Major, Corps of Engineers.

New York City, Dec. 2, 1903.

The report of the Board received the favorable indorsement of the Chief of Engineers, Gen. G. L. Gillespie, and the final action in the matter was taken by Secretary Root as follows:

I am constrained to deny the application of the City of New York for the extension of the pierhead line along what is known as the Chelsea Improvement, for the reason stated by the Board of Engineers in their report of December 2, 1903, and by the Chief of Engineers in his endorsement of December 4, 1903. I do this with great reluctance, for I approached the subject with a strong desire to comply with the wishes of the city government, and I agree with the officers of the city that New York should have piers capable of accommodating the largest steamships. It is not necessary, however, that this accommodation should be provided by further encroachment upon the water area of the harbor at what is now the narrowest part of the Hudson River opposite the city. It can be done either by constructing piers at points where the river is wider, or by digging out the shore end of the slips. Thousand-foot piers could be obtained in this way in many parts of the water front without going back into the land as far as the original water line. Any further encroachment upon the wat.: area by an extension of the pierhead line would practically be irrevocable; and having in view the probable future development of commerce along the Hudson River, I am satisfied that if such an extension were now granted, within a very few years it would be looked back upon as having been a serious mistake.

E. Root,
Secretary of War.

War Department, Washington, Dec. 9, 1903.

THE USE OF SCOWS AND SAND JACKS IN MOVING AND LOWERING A 1,000-TON DRAW BRIDGE OVER THE PASSAIC RIVER, AT NEWARK, N. J.

By Lincoln Bush.*

The moving of a bridge on scows in itself involves no feature of novelty, but the use of sand jacks for lowering a bridge a distance of 10½ ft. involves some engineering features that may be of interest.

The bridge in question is a new steel double-deck draw span, 220 ft. long, spanning the Passaic River, N. J., on the line of the Delaware, Lackawanna and Western R. R. The track elevation and track depression work that this company is doing through Newark involved the building of this double-deck bridge, and its subsequent movement from the old pivot pier to a new pier, 35 ft. upstream, and the lowering of the bridge so that the tracks on the lower deck will be at grade with the new freight tracks, and the tracks on the upper deck at grade with the new passenger tracks, Fig. 2, is a plan showing the relative position of the old and the new pivot piers, while Fig. 1 shows an end elevation of the bridge on the scows.

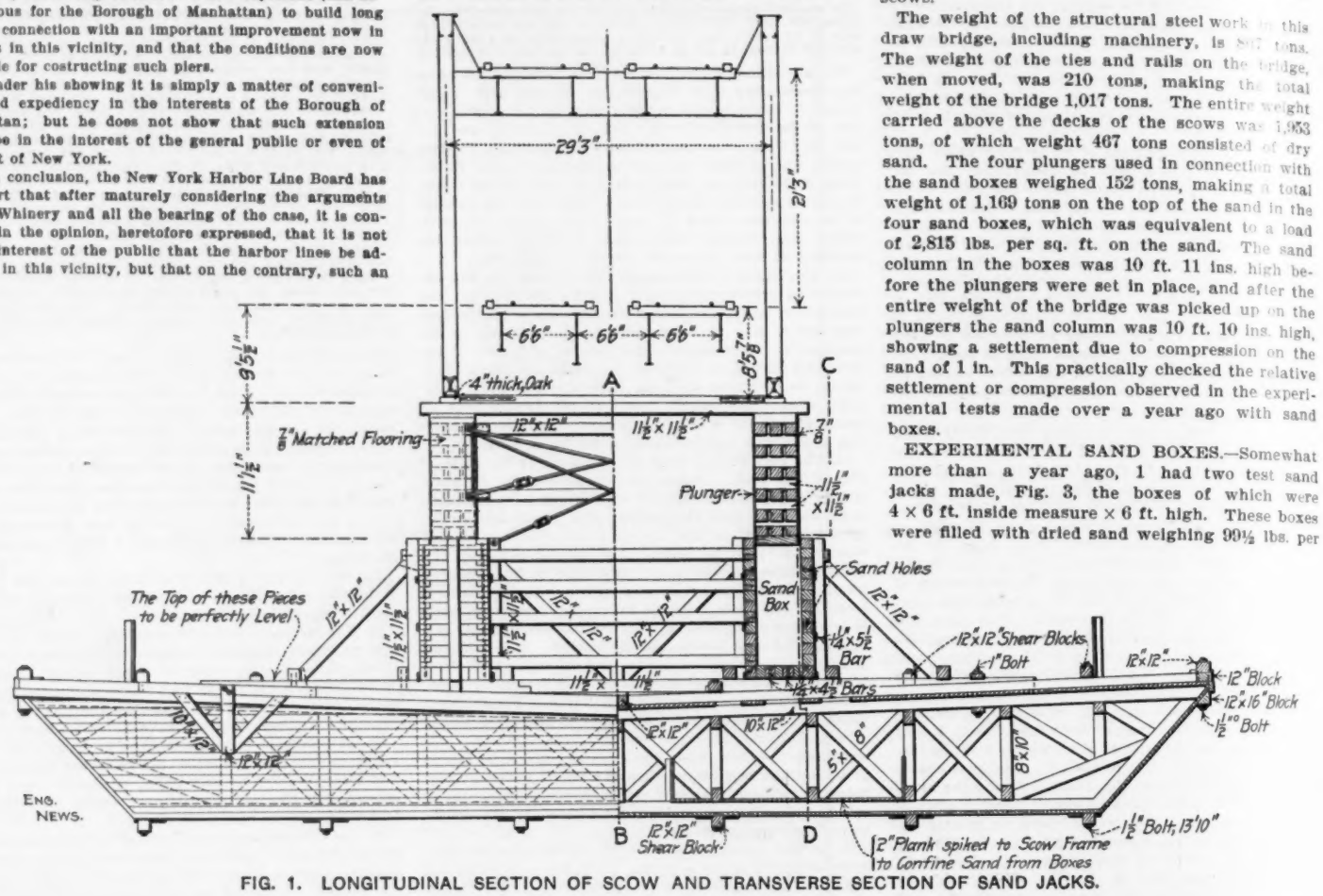


FIG. 1. LONGITUDINAL SECTION OF SCOW AND TRANSVERSE SECTION OF SAND JACKS.

The weight of the structural steel work in this draw bridge, including machinery, is 807 tons. The weight of the ties and rails on the bridge, when moved, was 210 tons, making the total weight of the bridge 1,017 tons. The entire weight carried above the decks of the scows was 1,953 tons, of which weight 467 tons consisted of dry sand. The four plungers used in connection with the sand boxes weighed 152 tons, making a total weight of 1,169 tons on the top of the sand in the four sand boxes, which was equivalent to a load of 2,815 lbs. per sq. ft. on the sand. The sand column in the boxes was 10 ft. 11 ins. high before the plungers were set in place, and after the entire weight of the bridge was picked up on the plungers the sand column was 10 ft. 10 ins. high, showing a settlement due to compression on the sand of 1 in. This practically checked the relative settlement or compression observed in the experimental tests made over a year ago with sand boxes.

EXPERIMENTAL SAND BOXES.—Somewhat more than a year ago, I had two test sand jacks made, Fig. 3, the boxes of which were 4 × 6 ft. inside measure × 6 ft. high. These boxes were filled with dried sand weighing 99½ lbs. per cu. ft., and of the quality used later in the actual bridge lowering. The plungers in these boxes were loaded with two 83-ft. steel girders, giving a load of 2,250 lbs. per sq. ft. on the sand under each plunger. The actual load on the huge plungers under the bridge was 2,815 lbs. per sq. ft. In order to test the flow of sand under pressure, 2-in. holes were bored in the box, hori-

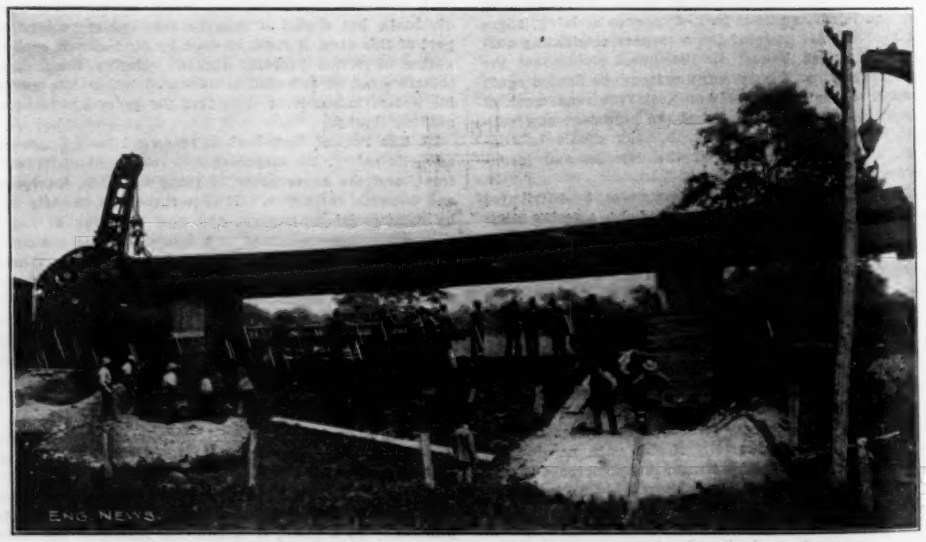


FIG. 3. TEST SAND JACKS LOADED WITH GIRDERS.

*Chief Engineer, Delaware, Lackawanna & Western R. R., Hoboken, N. J.

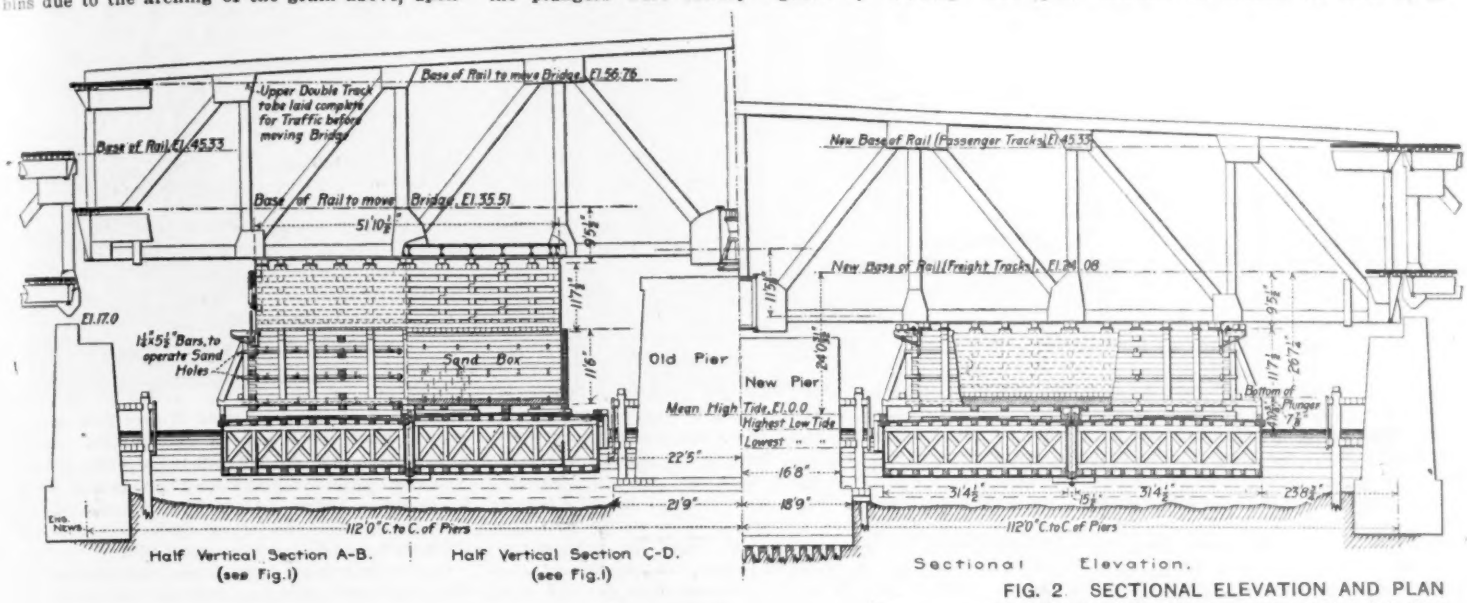
zontally, at an angle of 30°, and at 45°. These holes were widened to 3 ins. on the inside; thus tapering from 3 ins. to 2 ins. diam. through the 8-in. thickness of the sand box walls. It was found that even under the great pressure (2,250 lbs. per sq. ft.), sand would not flow through the horizontal holes; and it flowed through the 30° holes so as to fill about one-third their area; while through the 45° holes it flowed so as to almost fill the orifice. Through the holes bored vertically in the bottom of the box the sand flowed much faster than from any of the others. It might be inferred from these tests that the horizontal thrust would not be great, but the failure of grain bins due to the arching of the grain above, upon opening the doors below, was a phenomenon not to be ignored.

To determine whether the sand would absorb enough moisture from the air to render it liable to stick and arch, it was decided to leave the dried sand in these experimental sand boxes for several months, only roofing them over so as to keep out the rain. After five months' exposure on the company's dock at Hoboken, N. J., and during a rainy fall and winter, the sand was found to still run freely. In this connection, I would add that the sand was clean, sharp sand that had been screened through a ¼-in. bar screen, and was taken from the same pit from which the company obtains its sand for concrete work on the M. & E. Division. The 5½-ft. column of sand was compressed only ⅛-in. under the load of 2,250 lbs. per sq. ft.

Reverting to the actual lowering of the plungers of the two test sand jacks, it should be said that even when the plungers were descending at a rate of 1½ ft. per min., there was no jerking, nor was there the slightest bulging of the boxes. One of the plungers was started with a decided tilt from the vertical, but by drawing off the sand from under the high side, it was readily righted. Tests were purposely made to see whether binding of the plungers on the boxes could be effected by drawing off the sand on one side, but it was found that the plungers were readily righted by drawing sand from the other side, and that binding did not occur.

In these experimental tests, as well as in the sand jacks used to lower the draw bridge on Dec. 20th, a clearance of ½-in. all around was provided between the sides and ends of the box and the plungers. The bottom course of timbers of the plunger was rounded to about a half-inch radius to prevent catching on sides of boxes. The movement of the plungers in lowering, both in the tests and in the bridge lowering, was an absolutely steady movement, and in no case throughout the work was there a sudden movement of the plungers observed. No flow whatever of the sand upward through the ½-in. space between box and plunger occurred.

THE SAND JACKS.—As above noted, the unique feature of this bridge moving was the use of four huge sand jacks for lowering the bridge 10½ ft. Each of these sand jacks consisted of a box made of 12 × 12-in. yellow pine sticks laid crib-fashion, as shown in Figs. 1 and 6. Each box was 4 ft. 1 in. wide × 52 ft. long × 11½ ft. high. After these boxes were built on the scows, as shown, and after they were braced together, the plungers were built directly above the boxes, ready to enter them after the sand had been run into the boxes. The plungers were made 11 ft. high and had ½-in. clearance all around the sides of the


Upper Double Track to be laid complete for Traffic before moving Bridge
Base of Rail to move Bridge El. 56.76
Base of Rail El. 45.33
Base of Rail to move Bridge El. 35.51
New Base of Rail (Passenger Tracks) El. 45.35
New Base of Rail (Freight Tracks) El. 24.08
El. 17.0
14 - 5½" Bars, to operate Sand Holes
Sand Box
Old Pier
New Pier
Mean High Tide, El. 0.0
Highest Low Tide
Lowest " "
Bottom of Plunger
112'0" C. to C. of Piers
Half Vertical Section A-B. (see Fig. 1)
Half Vertical Section C-D. (see Fig. 1)
Sectional Elevation.

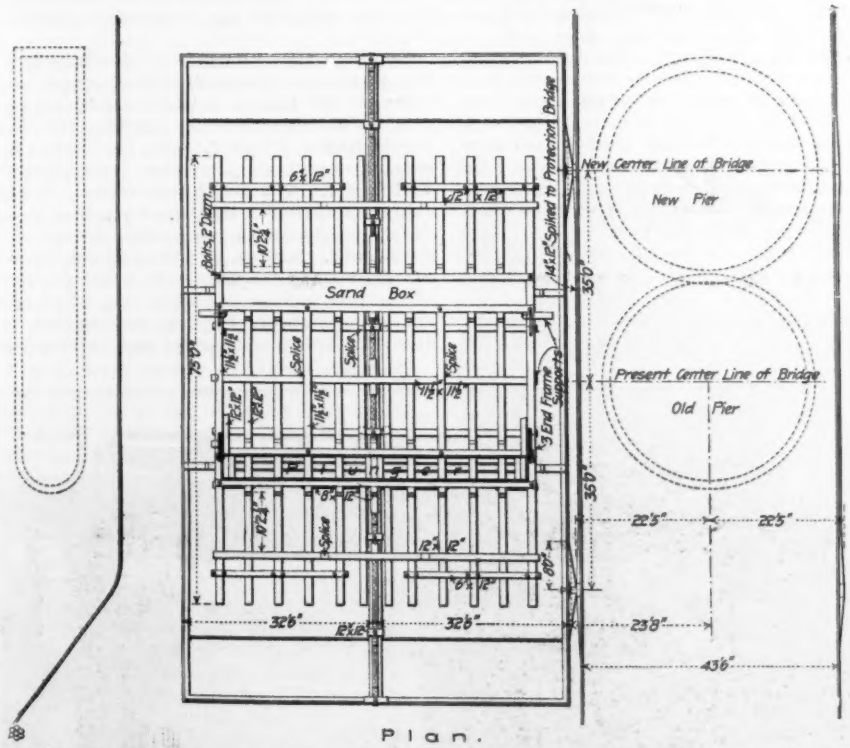


FIG. 2. SECTIONAL ELEVATION AND PLAN OF SCOWS AND SAND JACKS SHOWING OLD AND NEW POSITIONS OF DRAW BRIDGE.

boxes. It is interesting to note that although the plungers and boxes were made of carefully-dimensioned, dressed yellow pine, the actual height of each plunger was 1 in. more than the calculated height due to the slight, unavoidable width of joints between successive timbers. The sand which had been thoroughly dried some days before was brought in box cars to the bridge; holes were cut in the ends of the cars and the sand allowed to run through a 12-in. galvanized pipe directly into the sand boxes until they were filled within 7 ins. of the top. The plungers were then lowered with four 50-ton Norton jacks, one end of each plunger being lowered a few inches, and then the other end. When a plunger, which weighed 38 tons, rested fully upon the sand there was a settlement in the sand of ½-in. Later, when the bridge weight came upon the plungers a settlement of ⅛-in. more occurred. Planks were removed from the decks of the boats at the sand boxes, permitting the sand to run into the holds of the scows without any shoveling whatever.

Observation showed that the plungers were easily lowered at the rate of 1 ft. in four minutes. In lowering the bridge only one pair of boxes was worked at a time. The first operation consisted in lowering one end of the bridge 1 ft. The men were then shifted to the other pair of boxes and the sand allowed to run until that end of the bridge was lowered 2 ft. The men were then shifted to the other pair of scows and that end of the bridge was lowered 2 ft., so that one set of plungers was never more than 1 ft. higher or lower at any time than the other set. The plungers were painted with horizontal stripes 1 ft. apart in vertical height; and in lowering any one end of the bridge a distance of 2 ft. a halt was made at each foot mark, and any unevenness that the plungers showed was immediately adjusted by pulling sand from that portion of the plunger which was not down to the line.

By examining the details of the boxes it will be observed that there are three horizontal lines of holes in the sides of the boxes and two lines of holes in the bottom of the boxes. The holes in the slides for opening the sand holes in the boxes were

so arranged that all ten holes in a line could be opened at once. Another movement of the slides would open the three end holes in each line, and still another movement of the slides would open four holes nearest the center of the sand box. By this means the sand could be drawn from any part of the box and the adjustment of the plunger made. Very little time, however, was taken up in these adjustments of the plungers, as the sand adjusted itself to the pressure by relief through the holes. The experimental tests, as well as the work done in connection with lowering the draw bridge, show most conclusively that there was no intense lateral pressure from the sand against the vertical sides of the boxes, and that the sand acted practically as a column under the load of 2,815 lbs. per sq. ft. The sand running through the holes in the bottom of the box, as well as the holes set at an angle of 45° in the sides of the boxes, did not flow with force or as if under pressure. A very slight pressure of the hand over any of the holes was sufficient to stop the flow of sand.

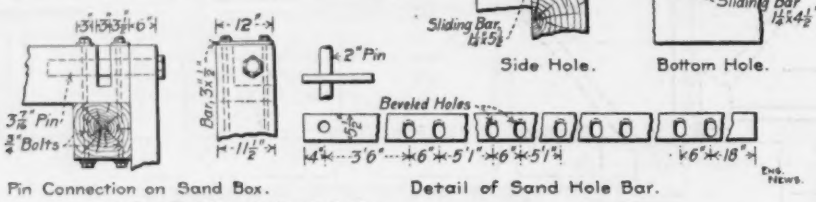


Fig. 4. Details of Sand Jacks.

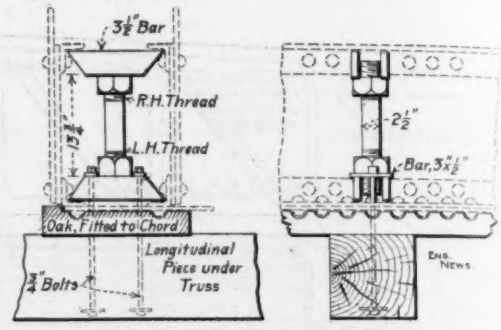


Fig. 4a. Details of Temporary Diaphragm.

The sand in an operation of this kind must be thoroughly dry. On Dec. 20, the day the draw bridge was moved, the work of lifting the bridge from the old pier was started at about 4 a. m., as that was the time that low tide should have occurred for getting the scows under the bridge. Low tide was not reached, however, until 4.55 a. m.; it had begun raining at Newark at 1.20 a. m., and it rained continuously until 5 p. m., during which time there was a total precipitation of 1.23 ins. In order to keep the sand dry large tarpaulins were placed over the tops of the plungers and hung down over the sides of the boxes. By this means the sand was kept dry except near the middle of one of the boxes. At the time the wet sand was discovered the plungers had been lowered about 5 ft. At this time it was observed that the sand was running freely from the holes near the ends of this box, but not so free from the holes near the center of the box, and also that the plunger was not lowering as fast as it should, and in fact stopped lowering for a period of about half a minute. This meant that the sand was crowning near the middle of the box, thus concentrating a heavy pressure at that point. All sand holes were at once closed, and an examination was made of the box. The timbers and bracing on the side of the box near the center indicated that a heavy pressure was concentrated near the middle. The wet sand did not reach far down, and the side holes nearest the middle of the box farther down and in the bottom of the box were then opened, and dry sand ran freely from them. These holes were allowed to run sand until it was assured that the pressure was relieved near the center of the box, after which time all holes were opened in this box in the regular way, and the plunger moved downward as gradually and as steadily as it had done in previous lowering of the 5 ft. This was the only difficulty experienced in the entire lowering with the sand, and caused a delay of about 20 minutes, and it is described in detail to emphasize the necessity of keeping the sand dry in an operation of this kind, as well as to illustrate the control over the sand under such circumstances.

The sand boxes were 54 ft. long over all, and the wooden slides that controlled the holes on any line were half the length of the box and were operated from each end. These slides were made so as to work easily in the construction, and no difficulty occurred in the actual operation from sand pressure. It was thought beforehand that a heavy rain would probably produce a swelling of the timbers and cause the slides to work hard, so a sufficient number of 2-in. plugs were provided in case trouble of this kind should occur. On the day the work was done the rain caused a few of the slides to work hard, so the plugs were substituted in such cases. Should I ever have occasion to handle a similar proposition again I would use either wooden or metal slides, and place short pieces of 2-in. pipe in the outlet holes of the boxes with the ends of these pipes projecting about ¼-in. outside of the face of the box so as to decrease the amount of sliding surface between the slides and boxes. I would not, however, change the size of the outlet holes from 2 ins. diameter, nor change their funnel shape inside of the box from 3 ins. diameter.

By referring to the details of the plungers it will be observed that they are trussed in pairs at their ends, by means of 12 × 12-in. timber struts and diagonal rods. There are also two other diagonal rods running from top of plunger to top of box, and these latter were used for plumbing the plungers after same were lowered into the boxes. The truss rods and 12 × 12-in. struts near the tops of the plungers were used for holding the plungers in position, while the weight of the bridge was being transferred from the old pier to the scows, and were left in place until the bridge was drawn up to the new center pier.

Before lowering the plungers with sand all truss rods were removed, as otherwise any uneven lowering of a pair of plungers would distort the truss they formed. The 12 × 12-in. struts between the plungers were left in place until the telescoping of the plungers into the boxes required their removal. This bracing between the plungers served a very good purpose, for it held the plungers absolutely in their true positions. No difficulty was experienced in removing either the truss rods or the 12 × 12-in. braces between the plungers. (For details see Figs. 1 and 2.)

THE TIDES.—The distance from the top chord of the bridge to the water line when the bridge was afloat on the scows was 66 ft., and from the top of the plungers to the water line before any lowering was done was 28 ft.; the scows having 2-ft. freeboard when the entire load was on them, and all water ballast out. The storm and wind on the day the draw bridge was moved caused the tides to be somewhat irregular, both as to time and height, especially the low tide in the afternoon, at which time the bridge had to be landed and scows released. Under normal conditions the first low tide should have occurred at 3.50 a. m., and should have been at a height of about 2½ ft. below mean tide. It actually occurred at 4.55 a. m., and was 1.9 ft. below mean tide. The high tide should have occurred at 9.50 a. m., and should have been about 2½ ft. above mean tide. It reached a height of about 3 ft. above mean tide at 10.45 a. m. The low tide in the afternoon at which time the bridge had to be landed and scows released, should have occurred at 4.40 p. m., and under normal conditions should have fallen to about 2½ ft. below mean tide. It reached its lowest stage at 5.30 p. m., and fell only 1 ft. below mean tide.

Observations made on the action of the tides at Newark covering a period of over four months showed that there were a considerable number of low tides that did not fall below mean tide, as well as a number of high tides that did not go above mean tide. These observations also showed low tides that fell 3 ft. below mean tide and high tides that rose 4 ft. above mean tide.

It will be noticed from these observations that the minimum variation between high and low tide was zero, and the maximum variation was 7 ft.

MOVING THE BRIDGE ON SCOWS.—In addition to the constant movement of switch engines there are 200 regular passenger trains that cross this bridge per week day, besides the regular freight trains. The D. L. & W. road carries 20,000 passengers each way per week day between New York and the suburbs of New Jersey. It was of extreme importance that the least delay possible should be caused to this traffic, as well as the river traffic. Sunday, Dec. 20, was selected as the day for making the move. To insure the success of the undertaking the bridge had to be moved and placed between low tide and low tide, or in about 12 hours, and means had to be provided

FIG. 5. D., L. & W. R. R. DOUBLE-DECK DRAW BRIDGE BEFORE MOVING; NEW PIER IN FOREGROUND.

such that the abnormal variations in the height of the tides would not defeat the undertaking.

The sand boxes and plungers were so constructed that the difference between the elevation of grade line of the bridge on the old location and the grade line of the bridge on the new location amounting to 10.5 ft. could be taken care of entirely by lowering 10½ ft. with the sand jacks.

The variations in the height of the tides and

the lifting of the bridge from its old location onto the scows, as well as the releasing of the scows from underneath the bridge in its new location, were controlled by means of water ballast, which was pumped in and out of the four scows by means of four centrifugal pumps, each having a capacity of 1,600 gallons per min. Each scow had

FIG. 6. SAND JACKS UNDER CONSTRUCTION.

placed upon it a centrifugal pump, each with an 8-in. suction and a 6-in. discharge pipe so arranged that the suctions and discharge pipes could be quickly changed so as to pump into or out of the scows. The two boilers that furnished steam for the two pumps used with a pair of scows were connected so that either pump could be run alternately from one boiler in case any boiler should fail to furnish steam. In addition to each scow being provided with a complete pumping outfit, a reserve pumping outfit, including pump, engine and boiler, was placed on a pontoon so that in case of emergency this pontoon could be pulled up to any one of the scows and utilized instead of the regular outfit provided. This proved a wise precaution, as one of the boilers foamed, and an 8-in. suction hose was broken on one of the pumps, so that the entire reserve outfit was utilized except one pump. I have had to do with the moving of seven bridges by means of scows, water ballast and centrifugal pumps, and in two cases out of seven an emergency outfit for pumping was brought into service.

In order to make certain of getting under the bridge at low tide, the distance from the top of the plunger to water had to be of such height that the scows could be floated under the bridge at the highest low tide which might be at mean tide. Should such a high low tide occur it would be necessary to have sufficient water ballast in the scows to pick up the weight of the bridge, for otherwise the scows would be sunk by the rising tide, as there was only 2 ft. freeboard, with all the load on and water ballast pumped out, while the weight of the bridge was such as to require a draft of 2½ ft. At the same time it was necessary in case the high tide did not rise above mean tide to have water ballast enough to pump out of the scows to lift the bridge high enough to clear the old pier at the lowest high tide. It was also necessary to have the adjustments such that the bridge could be landed on the new pier and the scows released at the highest low tide, which might be at mean tide. Note that low tide in the afternoon fell only 1 ft. below mean tide. At 4 a. m. the scows were under the bridge and their pumps started to pump out the water ballast. At 6.30 a. m., the bridge was raised, and so quiet was the raising process that not a creak told that the bridge had been lifted off its pier and was resting on the plungers.

On the protection pier were mounted a 4-spool and a 6-spool hoisting engine, having two ropes going to the tackle, fastened to the bows of the scows, while two more ropes from the other two drums passed around snatch blocks at the downstream end of the pier to the tackle fastened to the stern of the scows. The tackle consisted of triple blocks giving six falls, and so multiplying the engine power six times. Other ropes from the scows passed through snatch blocks to the winch heads of the engine, so that every movement of the scows was under perfect control.

It took just 20 mins. to move the bridge upstream the 35 ft., and at 9.35 a. m., the work of lowering was begun.

In order to center the bridge perfectly, an inverted centering cast-iron cone was bolted to the new pivot pier, with its center exactly in the center of the rack circle. The draw span, it should be remarked, is center bearing. When the bridge was let down so that its lowest point was within 7 ins. of the top of the new pier, the cone-shaped pivot base engaged the cone on the pier, so that by the time the bottom of the pivot base just cleared the masonry the bridge was accurately centered. If hydraulic jacks had been set upon the pier to effect the lowering, it is evident that much more difficulty would have been encountered in centering than with sand jacks on scows at all times movable. Incidentally it may be added that the sand jacks were much less expensive than hydraulic jacks would have been, aside from being much quicker in operation. Moreover, with sand jacks the lowering of the bridge was begun as soon as it had been shifted laterally so as to clear the old pier, and this lowering continued regardless of tide conditions; whereas, with hydraulic jacks the lowering could not have begun to advantage until the low tide, which in itself would have prolonged the time of starting the lowering some 12 hours. The bridge touched the new pivot pier at 5 p. m., and all scows were released from underneath it at 6.15 p. m.

The entire work was completed within the scheduled time, and the first train crossed the bridge about 8.30 p. m., at which time all track changes had been completed. There was a force of about 45 men on the scows, pumps, sand jacks, engines, etc., also a force of about 150 trackmen for raising and shifting tracks.

It is a well-known fact that the handling of a heavy load with hydraulic jacks is a tedious and slow process; the shifting of jacks and cribbing itself consumes much time. In this connection I would again call attention to the construction of the sand box and plunger used for lowering with sand. The plunger, except the bottom, consists of cribbing with openings through from side to side, 11½ ins. in height at every other course of timber. This plunger was sheeted with matched boards, except that three holes were left open in the side sheeting at each alternate course of the cribbing and jacking timbers, and jacks were provided to right the plunger if required by jacking between the top timber of the box and the timbers that could be readily shoved through the openings left in the sheeting of the plunger. Where heavy loads are to be raised or lowered by hydraulic jacks, it is evident that a plunger and box constructed like this one could be used, thus avoiding the necessity of shifting and constructing cribbing after the work had actually started.

The tide, wind, current in the river, and weather conditions, on the day the bridge was moved, formed as unfavorable a combination for such an undertaking as would probably ever occur. The fact that the bridge was pulled upstream, resting on the plungers, with its top chord 66 ft. above the water, that no hitch occurred in the work that made it necessary to change the program, or resort to other means than those at hand, and that the work was completed on schedule time proves conclusively that the sand jack for lowering a heavy weight is a most efficient and safe device.

FIG. 7. DRAW BRIDGE AFTER MOVING UP-STREAM AND IN PROCESS OF LOWERING ON SAND JACKS.

[Small sand jacks have been used for lowering the centers under masonry arches, and it is claimed that the Egyptians used larger sand jacks for lowering huge stones to place, but obviously neither of these uses of sand gave more than the slightest precedent for the bold engineering feat

which Mr. Bush has so successfully accomplished. Having conceived the idea of using sand jacks for lowering the draw bridge over the Passaic River, Mr. Bush made his own precedent. He did this, as he has related above, by building two test sand jacks and loading them with girders until the pressure upon the sand was 2,250 lbs. per sq. ft.—a pressure only 20% less than that actually used in the subsequent bridge lowering. These test sand jacks were so manipulated as to prove conclusively to their designer that no sticking or binding of the plungers in the box was possible, unless the sand should become wet. There was ½ in. clearance all around each plunger, and it had been predicted by one critic that the sand would be forced up into the space between the plunger and the box, thus causing binding. Nothing of the kind occurred, however. It had also been predicted that the dried sand might absorb enough moisture from the air to cause an arching that might burst the sand boxes. Mr. Bush answered this criticism by leaving the sand in the test boxes all winter; and at no time did it show any tendency not to flow freely.

Among the interesting facts learned from these experimental jacks was the fact that 2-in. horizontal holes through the 8-in. sides of the sand boxes would not pass sand at all, even under the enormous pressure to which the sand was subjected. Even in the case of holes bored upward at an angle of 45°, the flow of sand could be stopped by the pressure of the hand. The distribution of pressure in granular masses is as yet imperfectly understood; and, knowing this, Mr. Bush pursued the wise course of making tests on a large scale before attempting the actual bridge lowering.

The credit which Mr. Bush will receive for having so greatly extended the field of usefulness of the sand jack, will be increased rather than lessened by the fact that he tempered his boldness with caution. When we consider how much was at stake for the chief engineer who conceived and designed so bold a plan of bridge lowering, our respect for his inventiveness is only enhanced by the knowledge that he had foreseen and had provided for every condition that might have led to delay or disaster.—Ed.]

THE CINCINNATI WATER-WORKS TUNNEL.

By Paul G. Brown,* M. W. Soc. C. E.

The Cincinnati water-works tunnel will carry purified water from the filtration plant, located at a point eight miles up the Ohio River from the heart of the city, for a distance of 22,264 ft., to the pumping station in the east end of the city, where the water will be pumped into the reservoirs or forced through the mains for general distribution.

The intake was established near the Kentucky shore in a protected spot and connected with the pumping station by a short tunnel. The water being first pumped to the purifying plant and then passed through the long tunnel under a hydrostatic head of 161 to 172 ft., it will readily be seen that from an economic standpoint the tunnel must be water-tight.

The standard section is 7 ft. internal diameter, with 8½ ins. of vitrified bricks, ½-in. Portland cement mortar, and 6 ins. of Portland cement concrete, with a coat of mortar between the concrete and the rock, making the neat excavation 9½ ft. in diameter.

The material penetrated was limestone rock in nearly horizontal layers of from 2 to 12 ins. thickness, separated by layers of shale and clay, making the drilling exceedingly difficult. The work was prosecuted on well-known lines, the plant employed being that common to such work; though features of special interest were developed in the lining of the wet sections and the sinking of the No. 5 shaft.

Six shafts were sunk, dividing the work into ten drifts, single headings only being employed at the eastern and western termini. I will summarize briefly the general method: (1) Excavation, (2) mucking and trimming invert, (3) concreting invert, (4) bricking invert, (5) bricking arch.

*Superintendent for the Contractor, the W. J. Gawne Co., Cleveland, O.

(1) Sections of from 500 to 700 ft. were excavated; two 3¼ Ingersoll air drills were used in the face and approximately the full area of the section was taken, an average advance of 11 ft. being made in each heading each 24 hours. Two

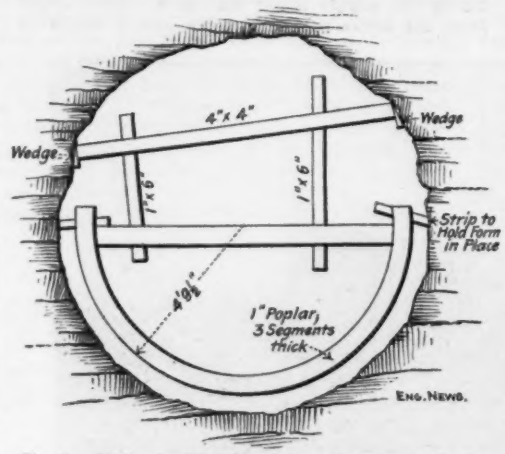


Fig. 1. Method of Setting Concrete Forms, Cincinnati Water-Works Tunnel.

drillers, two helpers, four muckers and a mule skinner were employed.

(2) The muck left to ballast the track was taken up and the irregularities of the rock removed, either by drilling and blasting or with a bull point, and the track run back to the face. Eleven men were employed from 12 to 16 days to prepare 700 ft. for concrete.

(3) Concrete was placed in the invert in 16-ft. sections, the forms being placed 4 ft. apart, and held in place as shown by Fig. 1. Six sections or 96 lin. ft. of invert were concreted each day. Eleven men were employed in the tunnel and five on top.

(4) For bricking the invert, track was again laid to the face on the concrete, as with the non-absorbent brick the work set too slowly to follow over the green work with materials. Two bricklayers on each shift averaged a hundred feet of brick invert each day, making about 2,500 brick per man per shift. Eleven men were employed in the tunnel and four on top.

The floor and track were laid and the trimming of the arch done while the bricklayers were at work. Eleven men would trim 700 ft. of arch in from 5 to 9 days.

(5) A light angle (3 × 4 × ⅜-in.) was bent to the proper radius, doubled and riveted together for a form for the brick arch; the tunnel being so small that economy of space was necessary for the rapid execution of the work.

The brick arch and concrete were then placed simultaneously, six or seven "set ups" being employed so the bricklayers could be kept continuously at work, while the concrete was being placed. Two bricklayers and 15 laborers were employed in the tunnel and 7 laborers on top. The progress was 64 ft. per day.

LINING THE WET SECTIONS.—In heading No. 1, 55 ft., and in heading No. 2, 158 ft., of water-bearing rock was encountered. Under the engineer's instructions air locks were placed in the drifts and the lining completed. Forty-two lbs. of air was held on drift No. 1 and at times as high as 48 lbs. was used and the supply of water was diminished but not stopped, so that when air pressure was let off there were many leaks in the masonry, making it necessary to employ calkers to shut off the water.

At No. 2 shaft the experience was about the same, so that it was determined to abandon the use of air entirely in the wet sections.

Where leaks could be traced to a definite origin, holes were drilled into the rock and a pipe calked into the same (Fig. 2), of such length that it would end in the inner course of brick, so that when the water was finally stopped the pipe could be covered over and the interior of the tunnel would present a smooth surface. A sleeve, nipple and elbow were added and the water led away from the section where work was being executed.

Where leaks occurred above the spring line, and could not be traced to a definite source, galvanized iron pans were built of such shapes as would conform to the surface of the rock, and the water drawn from the pans through the masonry with pipes as heretofore described. As many as 15 pipes have been placed in a section 16 ft. long.

In one section at the No. 4 shaft a leak developed in the bottom of the invert, after the excavation had been completed and before the concreting had begun, that furnished 180 gallons of water per minute. A 4-in. pipe placed in this leak could not be calked tight enough to stand the 20 ins. head necessary to hold water from the work. A trench was excavated in the rock 50 ft. long, 10 ins. wide and 8 ins. below sub-grade, and in this trench (see Fig. 3) was placed a 4-in. pipe,

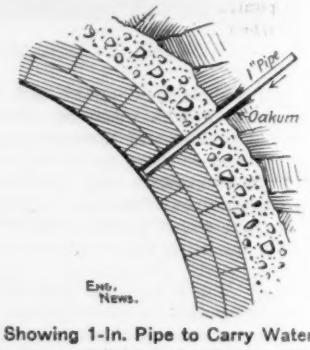


Fig. 2. Showing 1-In. Pipe to Carry Water Through Concrete and Brickwork of Tunnel Lining.

perforated for several feet from the end in the locality of the leak. This pipe was then packed in coarse gravel up to the tunnel sub-grade; then a layer of cement sacks was placed to keep the finer materials of the concrete from stopping up the perforations in the pipe, thus forming a "french drain," the operation of which was very successful (Fig. 3). Concrete and brickwork was then placed over the pipe without the slightest difficulty.

After the work had been in for several days a valve was placed on the pipe and connections made to raise the flow the 2 ft. necessary to continue the lining of the bottom. Some time after the arch was completed the valve was closed and the section showed absolutely water-tight con-

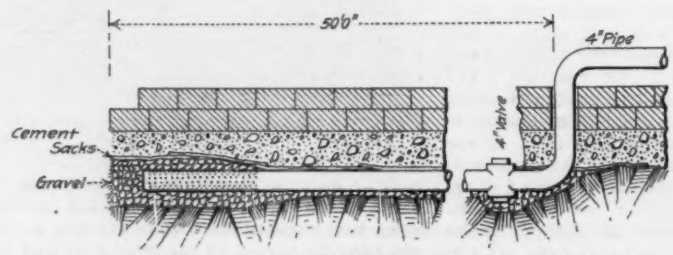


FIG. 3. METHOD EMPLOYED IN PIPING A TUNNEL LEAK OF 180 GALLONS PER MINUTE.

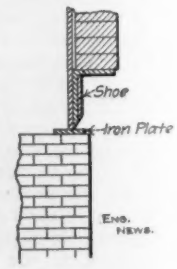


Fig. 4. Temporary Brick Wall Built Under Tunnel Shaft.

struction. After standing for several months connections were made with these pipes and grout under a pressure of 80 lbs. was injected until the leaks were entirely stopped and the character of the work assured.

THE NO. 5 SHAFT.—This consisted of a steel shell, lined with two rings of vitrified brick, and

is 174 ft from its top to the bottom of the sump, of which 121.9 ft. was through soft material. It was deemed inadvisable to attempt to sink the permanent shell to such a depth, because of the accuracy of location required.

An open timber pit was excavated to a depth of 20 ft. A temporary steel shell, lined with brick, was then sunk for a depth of 40 ft., an orange peel bucket being used for the excavation.

Sixty feet of the permanent shaft was then set in place, a proper adjustment was made to hold the alinement, and the shell lowered. Excavation was continued under water by the orange peel bucket and the sections added until lowered to rock without any difficulty. A diaphragm with an air lock was then paced on the shaft, the water blown out and excavation commenced.

Sections 4 ft. in length were excavated under the shoe and a temporary brick wall (Fig. 4) constructed to the circle of the shaft and iron plates placed on the brick wall at the proper elevation for the permanent location, the exact elevation being demanded on account of pipe connections. The air pressure was slightly lowered and the shell slid easily into place within 1-16-in. for elevation and 3-16-in. for location at the bottom.

Thin grout was then poured under the shoe of the shell for 48 hours, or until no more would be taken up, and the whole allowed to stand for a week. The pressure was then removed and the shaft found to be water-tight. Excavation with blasting was continued without employing a pump; less than 400 gallons being the daily supply when the tunnel level was reached.

The tunnel work is under the direction of a "Board of Commissioners," of which August Hermann is President; Mr. Gustave Bouscaren is Chief Engineer; Mr. J. A. Hiller, Resident Engineer; and the writer of this article is superintendent for the contractors, The W. J. Gawne Co., of Cleveland, O.

TWO PROBLEMS IN FIELD ENGINEERING.

By Arnold Emch.*

It should be one of the chief objects of mathematical research to test the value of its methods by their application to actual problems in the physical sciences and in engineering.

In what follows the writer will give the solution of two problems in field engineering. The first is an application of the theory of bicircular quartics, the second an application of projective geometry

I.—A COMPOUND CURVE PROBLEM.—Given two tangents, T_1 and T_2, of unequal length, their angle of intersection ϕ, and one radius R_1 of a compound curve joining those tangents; to find the length of the radius R_2 of the other branch of the compound curve.

In the treatises on field engineering this and similar problems are usually solved by a number of steps in which the usual instruments are used

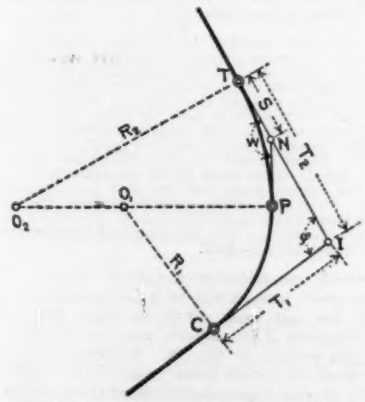


Fig. 1. Diagram for Problem I.

to get the geometrical solution. An analytic solution is possible, however, from which are obtained the final formulas given below, and which may be used in the field without any preliminary instrumental work.

It would be out of place in this journal to develop the analytic theory of those bicircular quartics which lead to a systematic solution of all problems of this kind, and it may be sufficient to give the result of this investigation for the proposed problem. For a complete theory of compound curves from the analytic point of view, the reader is referred to my article in the "Kansas University Quarterly," Vol. V., pp. 99-108.

Let in Fig. 1 the tangent distance of the other branch of the compound curve be S, which is shown as N T = N P. Let the given tangents be I C = T_1 and I T = T_2. In Fig. 1, C is the point of curve, T the point of tangent, P the point of compound curve. Then N T = N P = S (to be found), $\angle$ C I T = φ (given), $\angle$ T N P = w (to be found), C O_1 = R_1 (given), T O_2 = R_2 (required). We find,

$$S = \frac{T_1^2 + T_2^2 - 2\,T_2\,(R_1 \sin\varphi + T_1 \cos\varphi)}{2T_2 - 2\,(R_1 \sin\varphi + T_1 \cos\varphi)}$$

$$R_2 = \frac{T_1^2 + T_2^2 - 2\,T_2\,(R_1 \sin\varphi + T_1 \cos\varphi)}{2\,(T_1 \sin\varphi - R_1 \cos\varphi - R_1)}$$

$$\tan \tfrac{1}{2} w = \frac{T_2 - R_1 \sin\varphi - T_1 \cos\varphi}{-R_1 + T_1 \sin\varphi - R_1 \cos\varphi}$$

LOCATION IN THE FIELD.—On I T locate N such that N T = S. Set transit over N and turn off inwardly the angle w. On the new side of this angle lay off N P = S, by which the point of compound curve P is located. After P is known, the two branches of the compound curve

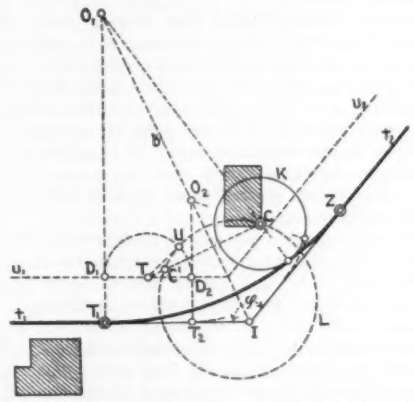


Fig. 2. Diagram for Problem II.; Geometrical Solution.

are located as usual. The problem admits geometrically of two solutions. The second solution, which is not indicated in the figure, gives a transverse curve, for whose second branch

$$S^1 = S = \frac{T_1^2 + T_2^2 - 2\,T_2\,(R_1 \sin\varphi + T_1 \cos\varphi)}{2\,T_2 - 2\,(R_1 \sin\varphi + T_1 \cos\varphi)}$$

$$R_2^1 = \frac{T_1^2 + T_2^2 - 2\,T_2\,(R_1 \sin\varphi + T_1 \cos\varphi)}{2\,(T_1 \sin\varphi - R_1 \cos\varphi + R_1)}$$

$$\tan \tfrac{1}{2} w^1 = \frac{T_2 - R_1 \sin\varphi - T_1 \cos\varphi}{R_1 + T_1 \sin\varphi - R_1 \cos\varphi}$$

where S^1, R_2^1, w^1 have the same meaning as S, R_2, w in the compound curve.

II.—APOLLONIUS' PROBLEM IN RAILWAY LOCATION.—Two tangents t_1 and t_2 include a given angle ϕ. At given distances from t_1 and t_2 is the corner C of a building. It is required to connect t_1 and t_2 by a simple curve having a given minimal distance from C.

The solution of this problem is usually made by analytic methods, which, in comparison with the graphic method explained below, are quite complicated.

The problem is evidently equivalent with the geometrical problem to construct circles tangent to two given straight lines, and to a given circle K. The two straight lines are t_1 and t_2, and the circle K is the circle having C as a center and the given minimal distance as a radius.

In this form, the problem is a special case of Apollonius' famous problem to construct circles tangent to each of three given circles. The graphical solution depends now on the following considerations:

If we draw any circle tangent to K and t_1, or t_2, Fig. 2, then a circle concentric with this circle and passing through C will touch the line u_1 parallel to t_1, or u_2 parallel to t_2, respectively, which are lines at a distance from t_1 or t_2 equal to the radius of K. Circles tangent to t_1 and t_2 and K have their centers on the bisector b of the angle between t_1 and t_2, and the corresponding concentric circles through C touch both lines u_1 and u_2, and pass through C', the symmetrical point of C with respect to the axis b.

The problem is therefore reduced to the construction of circles through C and C' tangent to one of the lines u_1 or u_2, because circles with centers on b and tangent to one of these lines will also be tangent to the other.

Circles through C and C' cut u_1 in an involution of points, whose double-points are the points of tangency of the required circle (circles). To find these double-points, draw any circle L through C and C'. Produce C C' to its point of intersection T with u_1. From T draw a tangent T U to L, and with T as a center and T U as a radius, describe a circle cutting u_1 in the required points D_1 and D_2. At these points erect perpendiculars on u_1, cutting b in the centers O_1 and O_2 of the required curves. The same perpendiculars also cut t_1 in the points of tangency T_1 and T_2 of the required curves with t_1.

In the figure, the solution answering the actual requirements of the field is represented by the curve T_1 Z, having O_1 as a center. The curve having O_2 as a center is a geometrical possibility without practical value, since the curve of largest possible radius is desired.

If the lines u_1 and u_2 are drawn below t_1 and t_2 at the same equal distances, and if the same construction is applied as before, two other geometrical solutions are obtained. Hence, geometrically, the problem admits of four solutions.

If the scale of the drawing is large enough it ought to be possible to obtain an accuracy of at least 1-500 for the radius O_1 T_1 and the tangent-distance I T_1. Even an accuracy of only 1-100 would in most cases be sufficient to choose the degree of curve, and consequently to compute the tangent-distance for a curve in such a manner that it would not deviate more than 1 or 2 ft. from the required distance from C. But if this distance is supposed to be 10 ft., there is generally no reason why it could not be at least 8 ft., or at most 12 ft. Thus, the graphical solution makes it possible to locate a curve within these limits without much preliminary computation.

It must be stated, however, that only the engineer is competent to judge the practical value and accuracy of the graphical method and its possible advantages or disadvantages over the analytic method.

SOME HOUSE METER RECORDS TAKEN IN NEW YORK CITY.*

By Arthur S. Tuttle,† M. Am. Soc. C. E.

It does not require a keen insight into the future to predict that the day will arrive when New York City must abandon the antiquated system now in vogue of charging water consumers on a scale in which the width of a building, number of stories and number of fixtures are the sole factors, unjustly taxing the small user for the benefit of those who wilfully or ignorantly waste water, and placing absolutely no obligation upon a consumer to make proper use of a supply, with the sole exception of advising him of the existence of rules which can, at best, be enforced only in small measure. The injustice of the present system to the metered consumers is evident from the fact that the revenue per million gallons from this source is far in excess of that from the unmetered supply.

In this latter connection I wish to call attention to the results of a rule made by the Department of Water Supply nearly two years ago, requiring all hose supplies to be taken through a meter. This regulation forced the installation of meters upon those consumers who had located in the suburbs for the purpose of having large open spaces about them, and who depended upon the use of garden hose to maintain the beauty and productiveness of their grounds and gardens.

I have compiled the records of about two dozen of the meters set during May, 1903, under these circumstances, each located on premises occupied by persons well known to me, and believe that the results submitted in the accompanying table, which includes eight typical cases, are of great value as illustrating the actual use of water under proper conditions. The houses are all three-story frame buildings, with front widths ranging from about 25 ft.

*Professor of Graphics and Mathematics, University of Colorado, Boulder, Colo.

*Abstract of a discussion on an "Additional Water Supply for New York City," at the meeting of the Municipal Engineers of the City of New York, Dec. 23, 1903.

†Assistant Engineer of the Board of Estimate and Apportionment, New York City.

to 45 ft., and, under the rates previously fixed, garden hose being charged at the rate of $2.50 per lot, the bills formerly ranged from about $20 to $35 per year, and in some cases would have been still higher if charges had been made for all of the lots connected with the premises and actually irrigated. A significant fact concerning these cases is that each is from a section where sewers have not been constructed and where cesspools serve for house drainage, with the result that leaks in fixtures have always been promptly attended to, and that great care has been taken to guard against leaving faucets running longer than necessary. In every case these consumers had previously lived in well drained sections, where they became fully accustomed to an unrestricted use of water sufficient for every need, and, so far as I have had opportunity to observe, none of the previous habits or customs have been altered with the sole exception of guarding against waste.

Commenting on this record, it should be noted that consumer No. 1 very largely omits the use of garden hose; for kitchen use he also depends partly upon a cistern, while all other consumers derive their entire supply through the meter. Consumer No. 7 maintains a large garden and keeps a man busy continually in caring for it, this care including much more extensive irrigation than in other cases, and probably much more than is required. Case No. 8 is an excellent comparative illustration of the result of an unintelligent use of water; the household consists of two adults and a servant, both of the former being absent from home at very frequent intervals and for prolonged periods, during which the servant is in full charge, this doubtless explaining the greater consumption of water, although the garden use is liberal.

If this object lesson could be sufficiently brought home to the residents of New York, if the present charter prohibition against the general introduction of meters in private dwellings were to be removed, and if meters could at once be generally installed, it is very evident that there would be no occasion for anxiety as to the adequacy of the present supply for many years to come. Unfortunately the prospect of an early realization of these ideal conditions is far from assuring, and even the most optimistic must place present hope in the carrying out of the plans of the commission, depending upon a gradual enlightenment of and demand by the public for the prevention of water waste, which demand the future is certain to bring.

Table Showing Consumption of Water in Private Dwellings in the Borough of Brooklyn During 1903, as Determined by Meter Measurements.

No.	No. of 20 × 100-ft. lots occupied.	No. of occupants.	Total faucets.	Av. daily consumption per family.	Av. daily consumption per consumer.	Water rate per year.*
1	12	6	16	68	11.4	$3.54
2	4	9	15	132	14.7	6.45
3	4	3	10	89	29.7	4.34
4	3	3	10	89	29.7	4.35
5	3	6	14	107	17.8	5.21
6	10	3	15	81	27.0	3.96
7	8	5	16	314	62.7	15.30
8	4	3	12	228	75.8	11.10
Averages			139		29.1	$6.76
Excluded			130		32.5	7.24

Notes by the Editor.—The table has been condensed and rearranged.

The observations covered 151 days for No. 1, 169 days for No. 3, and from 203 to 240 for the others.

Nos. 5 and 6 had two bath tubs; the others had one.

No. 4 had one water closet; No. 5 had 3; the others had two.

*At 10 cts. per 100 cu. ft., as based on meter record.

NOTES FROM THE REPORT FOR 1903 ON THE BROOKLYN WATER SUPPLY.

The report on the water supply of the borough of Brooklyn, New York city, for the eleven months ending Dec. 1, 1903, has just been completed by Mr. I. M. de Varona, M. Am. Soc. C. E., Chief Engineer under Mr. Robert Van Iderstine, Deputy Commissioner of Water Supply, Gas and Electricity. The average daily consumption and waste for the period was 104,397,465 gallons, or 83.6 gallons per capita, as compared with 100,305,485 and 82.9 gallons, respectively, for the year 1902. The rainfall for the first eleven months of 1903 was at the rate of 53.14 ins. per year, or 10 ins. above the average.

Among the particularly notable contracts let in 1903 were one for an infiltration gallery and two for slow sand filter beds, the latter to purify water from specially polluted sources. Two mechanical filter plants, constructed a year or more ago, but which failed to meet contract requirements, were reconstructed in 1903, and tests in progress when the report was made indicated that the filters will now be satisfactory. Plans for additional infiltration galleries have been made, and bids have been received for a special 16-in. fire main, from the Mount Prospect service to the river front. It is proposed to arrange this main so it can be supplied with either fresh water or salt water, the latter by means of fireboats.

The sanitary inspection service, up to Nov. 30, secured the cleaning of 17,569 privies and cesspools at a total cost of $3,595 (for inspection work). At the Mount Prospect laboratory examinations of water from the various supplies of all Greater New York, and also for the Commission on Additional Water Supply, were carried on under the direction of Messrs. Geo. C. Whipple, Assoc. M. Am. Soc. C. E., as biologist, and D. D. Jackson as chemist. During the year the chlorine in the water was unusually low, due to the heavy rainfall. The chlorine for the past six years has been: 1898, 13.1 parts per 1,000,000; 1899, 17.1; 1900, 17.6; 1901, 20.2; 1902, 20.2; 1903 (11 months), 10.3.

An unusually interesting series of observations on the effect of an Italian camp on the character of ground water was made. Driven wells were sunk in the sand to various depths and at various distances from a latrine. Surprisingly few tests for Bacillus coli in water from these wells were positive. It was concluded as "probable that with the ordinary fine sands and with low velocity of flow, water would be rendered practically safe for use by passing through a horizontal distance of about 25 ft." A full report on these studies was made to the Commission on Additional Water Supply.

Pitometer tests during 1903 brought some interesting facts. The annual revenues from unmetered water in nine selected districts, as figured on the consumption shown by the tests, ranged from 8.9 to 1.1 cts. per 1,000 gallons, as compared with the standard price of 13.3 cts. paid by metered consumers in the same districts. In these same districts the average charge for all water, metered and unmetered, ranged from 10.7 to 1.8 cts. per 1,000 gallons.

The consumption per capita in four types of districts, with the corresponding amounts paid per 1,000 gallons for unmetered water, were as follows: (1) Low to middle-class residential, 77 gallons at 6.4 cts.; (2) tenement, 52 gallons at 3.3 cts.; (3) middle to high-class residential, 58 gallons at 8.9 cts.; (4) same as (3), but with a large proportion of high-class residences, 86 gallons at 6.3 cts. Mr. de Varona concludes that the per capita consumption in Brooklyn is not large; that the disparity in rates between different classes of unmetered residences and the still greater disparity between unmetered and metered services calls for a readjustment of rates; that the waste from house leakage is large enough to warrant a house to house inspection, unless meters are installed; that night measurements of house leakage can be made only with difficulty, owing to defective curb cocks, which are owned by consumers "who would object to bear any portion of the cost of repairs or renewal where needed;" that the leakage from street mains is small; and that while the extension of the meter system in Brooklyn would not effect as large a saving in water consumption as some have claimed, it would be sufficiently large to warrant the introduction of meters, but that it would not be necessary to meter all services, since "experience in other places shows that the efficient limit of metering is reached before the meters have been placed on every service."

No more important economic problem exists in the water department of Brooklyn, the report states, than that of consolidating the 23 separate pumping stations. At present 10% of the supply is pumped once, 76% twice, 14% three times and 1% four times.

Finally, we can only mention at this time the interesting studies of the velocity of the underground flow on Long Island made by Prof. C. S. Slichter and by the water department.

CIVIL SERVICE EXAMINATIONS of candidates for civil engineering positions on the New York state barge canal work will be held on Jan. 12 and 16 by the New York State Civil Service Commission and by the local examining boards of the U. S. Civil Service Commission in a selected number of cities outside of New York state. The positions for which the examinations will be held include resident engineers, assistant civil engineers, levelers, rodmen, chainmen, engineering draftsmen, bridge designers, bridge draftsmen, junior bridge draftsmen, mechanical engineers and draftsmen. Applications for these examinations must be made on or before Jan. 7, 1904. Full particulars of the examinations and blank applications may be obtained by addressing the Chief Examiner of the Commission at Albany, N. Y.

THE SIMPLON TUNNEL by the end of November reached a total length of headings of 17,735 m., or 58,236 ft. Of this length there is 33,272 ft. in the north or Brieg end, and 24,964 ft. in the south or Iselle end. During the month of November alone the headings progressed 933 ft., over two-thirds of which is due to the south heading.

A CIRCULAR RELATIVE TO THE UNION ENGINEERING Building and the progress made in its planning has just been issued to the members of the American Society of Mechanical Engineers. For the most part it repeats the information given in the circular to the Civil Engineers, reprinted on page 509 of our issue of Nov. 26, but in addition the following estimate is given of the floor space which the several societies will require aside from general rooms for auditoriums and library purposes:

Purpose.	Electrical.	Mechanical.	Mining.
Reception room	600	800	600
Editorial room	400	300	300
Secretary or Assistant	400	300	300
Counting room	600	600	300
Accountant—Stenographers	400	900	700
Board and Committee	1,000	600	700
Stationery and Transactions	1,200	1,200	1,000
Closets	400	400	400
Sundries	200	400	600
	5,200	5,500	5,120

The American Society of Civil Engineers is said to estimate its floor space requirement at about 9,000 sq. ft.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Baltimore & Ohio R. R. near Dawson, Pa., on Dec. 23. An east-bound fast through passenger train was derailed by running into an obstruction on the track, the forward part of the train was completely wrecked, the smoking car was thrown on top of the locomotive boiler and filled with steam so that most of its occupants were scalded to death, and finally the wreckage caught fire; sixty-five dead were taken out of the wreck by the next morning, most of whom were, no doubt, killed instantly.

This is the worst railway accident which has occurred in this country for years. It is unusual, moreover, in the cause that brought about the derailment. The train was a regular east-bound limited passenger train, the "Duquesne Limited," bound for Washington and New York; it was the fastest train on the Baltimore & Ohio. The train left Pittsburg, Pa., at 6:30 p. m. of Dec 23. The wreck occurred at 7:45 p. m., while the train was running at full speed, about sixty miles on hour. From what is known at present it is concluded that a freight train passing a few moments before the limited, had dropped some long timbers from a gondola car whose sidestakes gave way. The limited struck these timbers and was thrown from the track, the forward part down the embankment toward the Youghiogheny River. The sleeping and dining cars were not much damaged, but the smoking car, which was forward just behind the baggage car, was crushed and thrown on the boiler, where it was filled with steam. Only one or two of those in the smoker remained alive, and these were seriously injured. An official statement by General Superintendent W. C. Loree, of Pittsburg, is as follows:

No. 12 was derailed by running into some switch timbers, or timbers of about that size, derailing the engine and all cars. All the cars are badly damaged. I do not think any of the equipment will be able to go away from the accident on their own wheels, except, possibly, the Pullman cars and the diner. The engine lies across both tracks. The baggage car is over the bank. The first coach is partly over the bank. The balance of the train badly twisted. I judge thirty-five people killed. All the people killed were in the smoker. Escaping steam from the engine went into the first coach, scalding the people. Very few of the other passengers were injured. The injured have been taken from the wreck, and are lying on the bank. The engineer and fireman cannot be found—(were killed.—Ed.).

A second exceptionally disastrous railway accident, though much less serious than the preceding, occurred during the past week. Two passenger trains on the Pere Marquette R. R. collided head-on near East Paris, Mich., the evening of Dec. 26. The list of dead in this wreck totals 22, while many others were injured. The west-bound train was to have stopped at the previous station, McCord's, to get orders for meeting the east-bound. The operator at McCord's had the train-order signal out, but it is said that a blizzard which raged at the time blew out the red signal light within a few moments before the train reached the station; the operator saw the train run by, reported this to the dispatcher, and then found that his signal had blown out. Meanwhile the east-bound had already left the last station and nothing was left but to get out the wreck-train. The east-bound train was running slowly and the destruction occurred almost solely on this train. The mail car drove the smoker and following parlor-car together, and the deaths occurred in the wreck of these two cars.